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BINGHAMTON WASTEWATER MANAGEMENT STUDY. SPECIALTY APPENDIX.(U)

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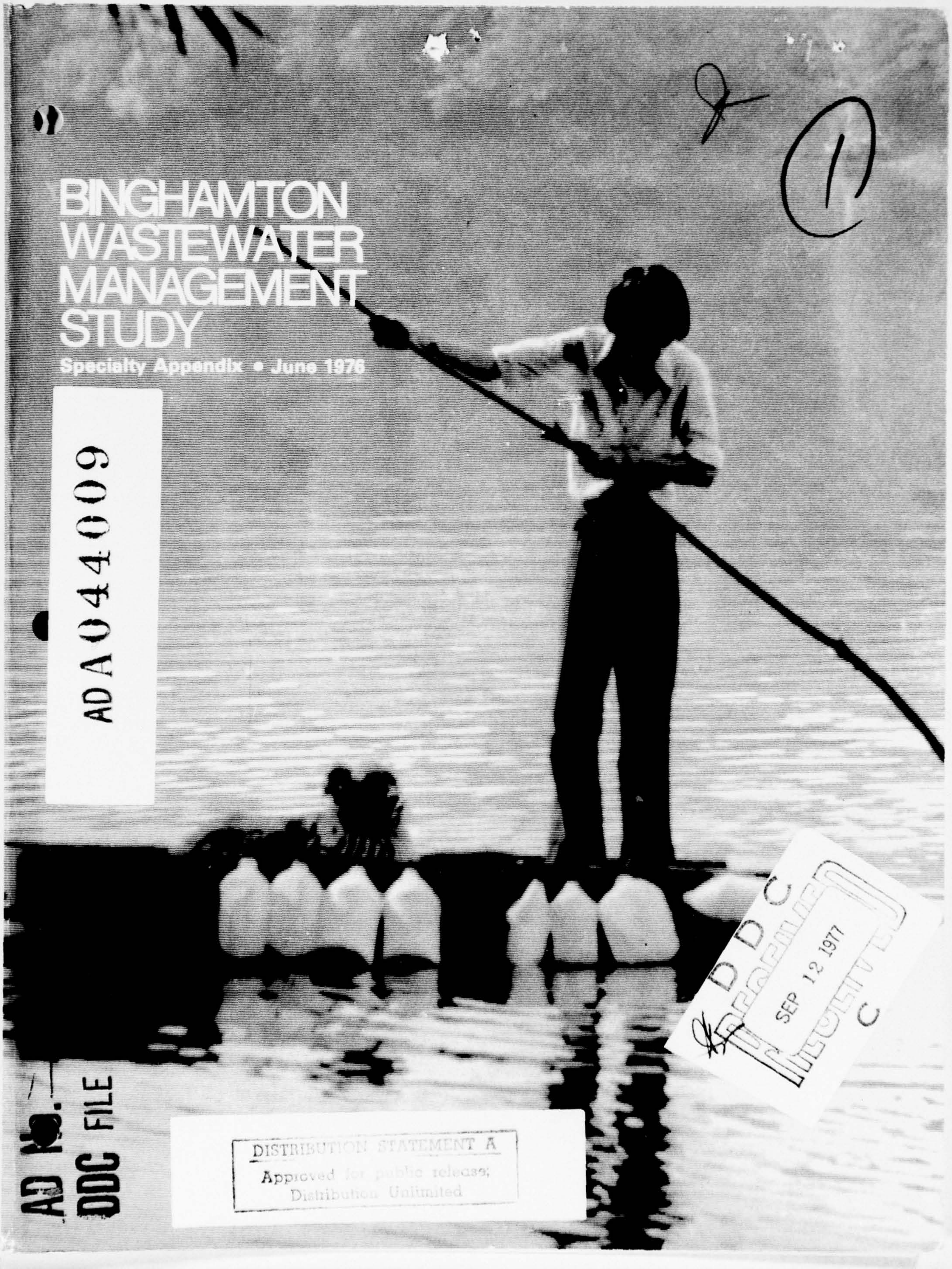

BINGHAMTON WASTEWATER MANAGEMENT STUDY

Specialty Appendix • June 1976

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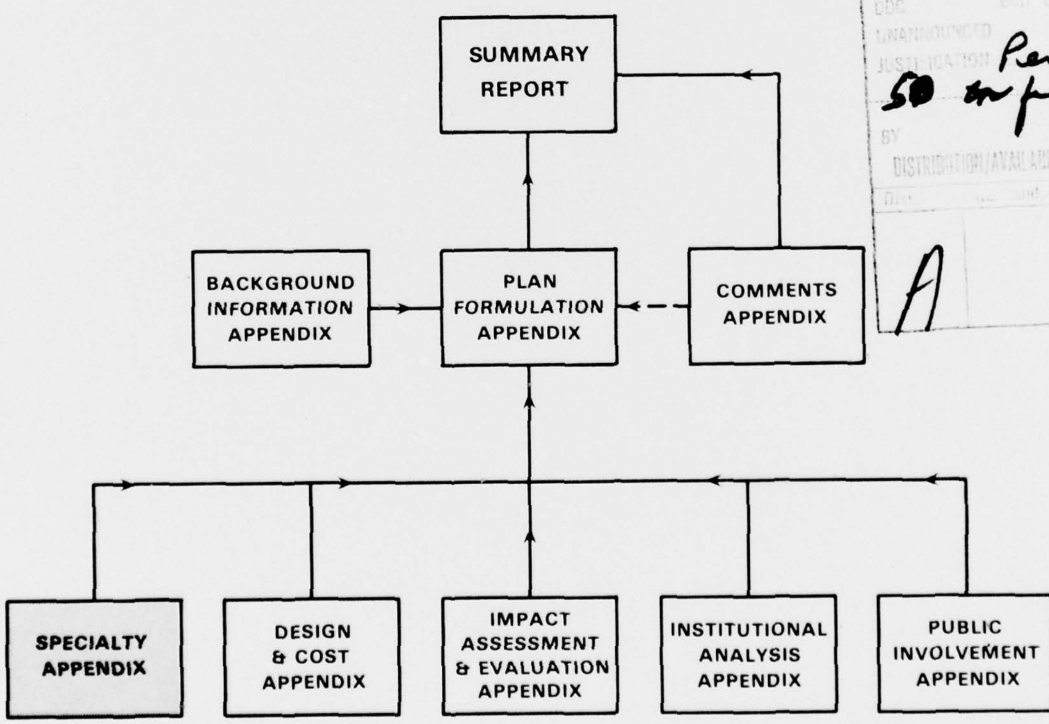
"The Raft of Summer"
Courtesy of Paul Smith, Binghamton, New York

Someone once said a picture is worth a thousand words, and the cover photograph summarizes the study in a simple but graphic manner. Today, the modern Huck Finn can enjoy many scenic and recreational opportunities associated with a Susquehanna River relatively free of pollutants. But tomorrow when the boy is grown, will the river still offer clean water for his children's enjoyment? This study suggests some ways to keep the Susquehanna clean and to ensure that future generations in Broome and Tioga Counties can enjoy "The Raft of Summer."

The Report for the Binghamton Wastewater Management Study consists of nine appendices. The Summary Report, Background Information Appendix, Plan Formulation Appendix, and Comments Appendix constitute the primary Study documents. The five remaining documents support the Plan Formulation Appendix. The relationship of the Specialty Appendix to the other documents is indicated in the diagram below.

A number of issues arose during the course of the Study that were not related directly to other appendices. Therefore, a Specialty Appendix was prepared and includes discussion and analysis of wastewater treatment in Outlying Communities, non-point source pollution, and the effect of wastewater management practices on river-oriented recreation. Land application of liquid sludge and secondary effluent, industrial wastewater management, nonstructural flow reduction schemes, and the report for the "Cultural Resources Reconnaissance" are also presented.



BINGHAMTON WASTEWATER MANAGEMENT STUDY

SPECIALTY APPENDIX

JUNE 1976

409 111

Prepared by the

BALTIMORE DISTRICT, CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY

290 p.

BINGHAMTON WASTEWATER MANAGEMENT STUDY

SPECIALITY APPENDIX

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CHAPTER I

INTRODUCTION

During the course of the Binghamton Wastewater Management Study, several issues and concerns surfaced that required special investigation. These issues and concerns usually were not related directly to either impact assessment and evaluation, design and cost, public involvement, or institutional arrangements as specifically defined in the other appendices. Rather, the investigations usually took the form of broad ranging concerns sometimes overlapping more than one category within the appendices. For these reasons, a Speciality Appendix was prepared to document, in one convenient location, the work accomplished for the areas of special interest.

Chapter II discusses the importance of wastewater management in the Outlying Communities of Broome and Tioga Counties. Existing conditions are described, and options for centralized treatment of wastewater within the communities are proposed. Typical costs are calculated for a small village, and the basic steps for planning of a small wastewater treatment system are outlined.

In Chapter III, non-point sources of pollution are the topics of discussion. Because of their magnitude, combined sewer overflows (sometimes labeled as non-point sources) have been given separate attention in the Design and Cost Appendix. The present chapter briefly investigates nutrient and sediment pollution in the Bicounty Area, and describes a method for predicting such pollution. The major conclusion is that the Southern Tier East Region does not have any serious wide-ranging problems from non-point sources.

Because of the Citizens Advisory Committee's interest in primary contact recreation along the entire length of the Susquehanna and Chenango Rivers, Chapter IV analyzes the river-oriented recreational potential associated with the various wastewater management plans. The interactions of the Riverbanks Improvement Program and the various alternatives of the Binghamton Wastewater Management Study are also investigated.

Chapter V considers the possibility of applying secondary treated effluent and sludge to the land for recovery of valuable resources. Sludge application techniques and effluent application techniques are examined, and six sites are located for potential application.

Industrial wastewater management, including present practices and guidelines for future discharges, is the subject of Chapter VI. The level of treatment, volume of discharge, and the quality of effluent are discussed together with the existing laws and regulations applying to industries discharging to streams or municipal systems.

Chapter VII examines various methods of non-structural flow reduction measures. These methods include pricing, an education program to reduce flow, individual devices for the home such as faucet aerators or toilet adaptors, and institutional measures as zoning, building codes, and industrial surcharges. The chapter assesses the preliminary costs and effectiveness of these measures.

The final chapter reproduces the report prepared by Dr. Frederick Plog titled "Cultural Resources Reconnaissance." This chapter investigates the historic and prehistorical impacts associated with the various projects proposed by the Binghamton Wastewater Management Study.

CHAPTER II

WASTEWATER MANAGEMENT PLANNING FOR OUTLYING COMMUNITIES

For planning purposes, 17 wastewater management areas were designated in Broome and Tioga Counties. These areas were identified as having concentrations of existing development or a potential for future development. The wastewater management areas, divided into urban and outlying regions, are shown in Figure II-1.

The Binghamton Wastewater Management Study focused on the eight urban regions in the metropolitan area as these had a significant impact on water quality in the Susquehanna River. Since it was outside the scope of this Study, detailed analyses and specific recommendations were not made for each of the Outlying Communities of the Villages of Harpursville, Lisle, Whitney Point, and Windsor, in Broome County; and the Villages of Candor, Newark Valley, Nichols, Spencer, and Waverly, in Tioga County. However, a general analysis was performed to aid these Outlying Communities in their water quality planning programs.

The purpose of this analysis for the Outlying Communities was to:

1. Identify, in an overall manner, the existing conditions of wastewater management;

2. Present a detailed examination of the centralized wastewater treatment options available;

3. Present an analysis of costs involved in a centralized system for a hypothetical community, typical in size and density of a Broome-Tioga community;

4. And discuss the planning steps necessary for the solution of wastewater management problems existing in any of the Outlying Communities.

BICOUNTY STUDY AREA

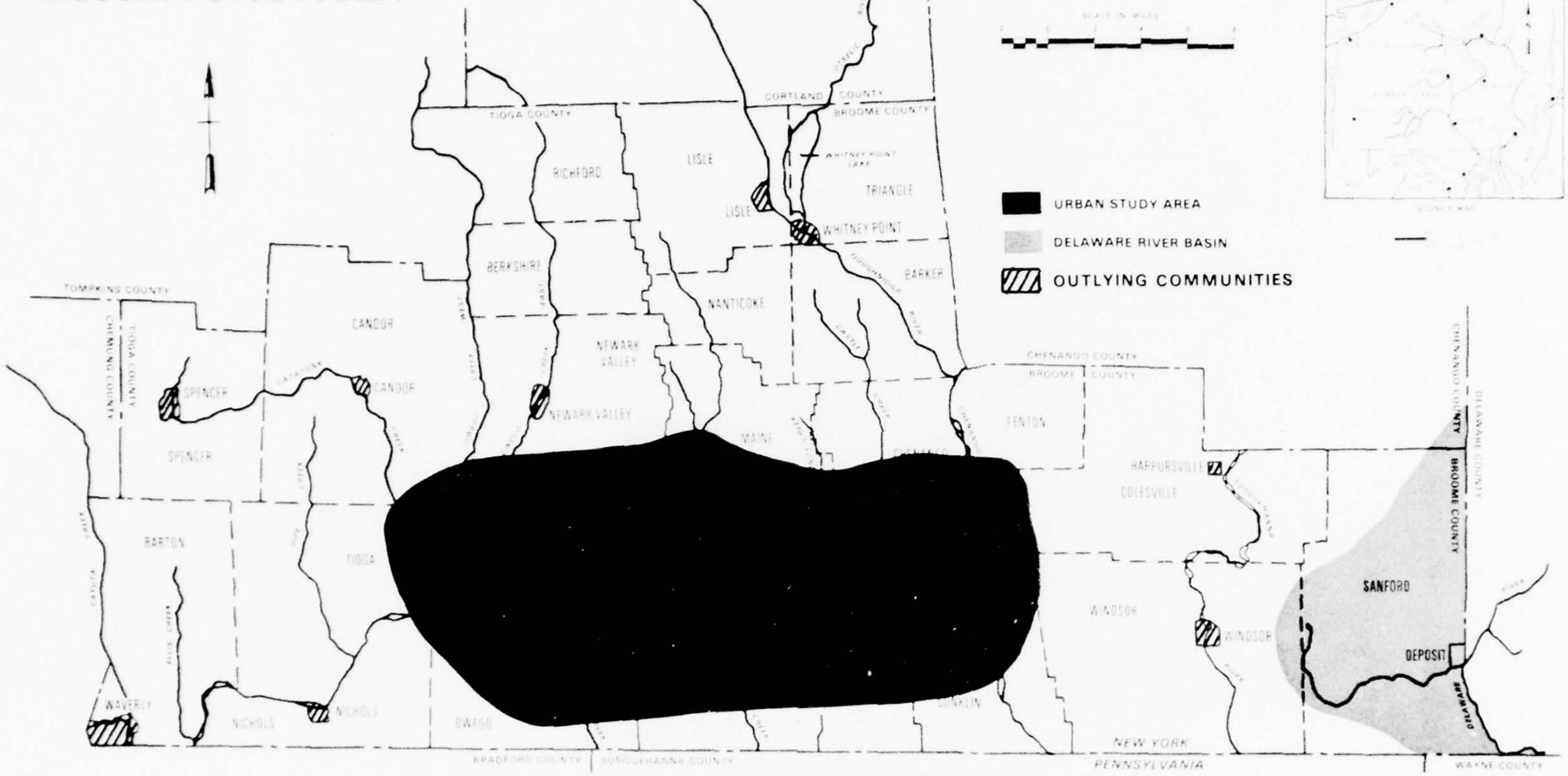


FIGURE II-1

Also discussed are recommendations of the Broome County Sewage Feasibility Study conducted by Clinton Bogert Associates in 1969, and the Tioga County Comprehensive Sewage Study by R. J. Martin in 1970.

A preliminary economic analysis of total Bicounty Area regionalization (i.e., conveying wastewater from the Outlying Communities to the metropolitan area for treatment and disposal) indicated such a system would not be cost-effective. In the same manner, combining the waste from any two or more of the Outlying Communities for common treatment was also economically unjustified except possibly in the case of Lisle and Whitney Point. The distances between Outlying Communities and the metropolitan area were greater than distance over which wastewater could economically be pumped. Thus, planning for wastewater collection, treatment, and disposal systems was considered separately for each community.

EXISTING SITUATION

The Outlying Communities are residential in nature with light commercial and industrial development. With the exception of Waverly, the villages do not have public sewers and are currently served by individual home treatment systems (septic tanks).

Population projections for the Outlying Communities are presented in Table II-1. These projections are somewhat lower than the estimates used in the two earlier comprehensive studies. The projections shown, however, do parallel the municipal projections derived by the Southern Tier East Regional Planning Board to the year 1990 with New York State Office of Planning Services (OPS) projections (issued in 1974) used for the years 2000 and 2020.

Considering the nature of the Outlying Communities, a wastewater flow rate of 110 gallons per capita per day (gpcd) was used as characteristic of residential areas with light commercial and industrial activity. The flow rates used in the Tioga County Comprehensive Sewerage Study ranged from 106 to 116 gpcd. Table II-2 summarizes the wastewater

TABLE II-1

POPULATION PROJECTIONS FOR OUTLYING COMMUNITIES*

Village	1970	1980	2000	2020
		BROOME COUNTY		
Harpursville	----	400	750	1400
Lisle	336	400	400	450
Whitney Point	1058	1200	1300	1800
Windsor	1098	1200	1400	1800
		TIOGA COUNTY		
Candor	939	1150	1600	1850
Newark Valley	1286	1450	1950	2350
Nichols	638	700	1000	1200
Spencer	854	1100	1950	2250
Waverly	5261	4600	4100	4100

* Based on Southern Tier East Regional Planning Board and New York State Office of Planning Services projections.

flow projections based on the per capita flow rate of 110 gpcd and the population estimates.

General characteristics and the status of existing water and wastewater management systems for each of the Outlying Communities are discussed below.

BROOME COUNTY

Village of Harpursville

The Village of Harpursville, in the Town of Colesville, is located on the west bank of the Susquehanna River where it flows south from Chenango County into Broome County. The community is mainly residential with a small commercial center serving the Village and surrounding agricultural area. The Village population is expected to increase after the construction of US Route I-88, and is projected at 750 and 1,400 persons for years 2000 and 2020, respectively.

The Village does not have public water or public sewers at this time. Local soils are primarily well-drained, so that existing sub-surface treatment systems (septic tanks) are operating well and are expected to serve for quite some time.

The Broome County Sewerage Feasibility Study, 1969, recommended the construction of interceptors in 1980, with a 0.3 mgd aerated lagoon treatment system. However, based on the population projections developed for this Study, the wastewater flow for the year 2020 is estimated to be only 0.15 mgd.

Village of Lisle

The Village of Lisle, in the Town of Lisle, is located on the west bank of the Tioughnioga River, approximately one mile west of the southern portion of Whitney Point Reservoir. The community is essentially rural in nature and is expected to remain so in the future. Water supply is obtained from four springs. The major commercial center in the Village is a co-op marketing agency which handles milk. The milk waste is treated with a septic tank and a leaching field.

The wastewater flow for the year 2020 is projected at 50,000 gallons per day. The well-drained soils indicate that septic

TABLE II-2

WASTEWATER FLOW PROJECTIONS FOR OUTLYING COMMUNITIES

Average Wastewater Flow, MGD

Village	1970	1980	2000	2020
		BROOME COUNTY		
Harpursville	----	0.04	0.08	0.15
Lisle	0.04	0.04	0.05	0.05
Whitney Point	0.12	0.13	0.15	0.20
Windsor	0.12	0.13	0.16	0.20
		TIOGA COUNTY		
Candor	0.10	0.13	0.18	0.21
Newark Valley	0.14	0.16	0.21	0.26
Nichols	0.07	0.08	0.11	0.13
Spencer	0.09	0.12	0.22	0.25
Waverly	0.58	0.50	0.45	0.45

Design Criteria--110 gallons per capita per day; populations presented in Table II-1.

systems will serve the Village satisfactorily for the next 25 to 30 years, at expected population densities.

Village of Whitney Point

The Village of Whitney Point is located on the west bank of the Tioughnioga River, two miles southeast of the Village of Lisle.

The community is residential with some commercial and industrial population. The strategic location of Whitney Point in a web of State highways (Route 81 and Route 11), makes the area prone to higher growth. The area is in close proximity to recreation centers such as Whitney Point Lake, Dorchester County Park, and Lisle County Park. The Village also serves as a small commercial center for adjoining agricultural areas.

The Village has a public water system and is served by four wells. There is no public sewage treatment system at this time. Wastewater from many of the dwellings is discharged untreated to the Tioughnioga and Otselic Rivers via storm sewers and drainage ditches. This problem has been a public health concern to the Village, Broome County Health Department, and the State for many years. The Broome County Sewer Feasibility Study (1969) recommended treatment for the Villages of Lisle and Whitney Point by constructing an aerated lagoon secondary treatment system, design capacity of 0.3 mgd to serve until 1992.

Construction grant applications were made for a treatment system to initially serve only Whitney Point. However, this project was defeated in a public referendum in 1972.

By the year 2020, population of the Village will reach 1,800, contributing approximately 0.20 mgd of wastewater flow.

Village of Windsor

The Village of Windsor, in the Town of Windsor, is located on the west bank of the Susquehanna River, as it flows south into Pennsylvania. The area north of the Village is preserved as a conservation area. This community is basically residential in nature with light commercial establishments centralized in the Village.

The Village has had a public water supply system since 1900. Usually, only one of two wells is used and the quality of the

groundwater is good. The Village does not have public sewers at this time. The soils for most of Windsor are well-drained Chenango silt loam and moderately well drained Tioga silt loam.

According to Southern Tier East Region General Plan, the area north of the Village and west to the conservation area is a potential growth area. The Village of Windsor is 15 miles east of the City of Binghamton. The population is expected to reach 1,800 by the year 2020. The Broome County Sewerage Feasibility Study (1969) had recommended to start constructing interceptors and an aerated lagoon secondary treatment system of capacity 0.2 mgd to serve until 1992 and then expand it to 0.4 mgd to serve until 2020. The wastewater flow projected for the year 2020 based on present population projections is 0.2 mgd, one half of the previously projected flow.

TIOGA COUNTY

Village of Candor

The Village of Candor, in the Town of Candor, is located in the Catatonk Creek Valley. Catatonk Creek meanders through the Village, dividing it into three sections. The Village is essentially a residential community having a light commercial center serving the Village and surrounding agricultural area.

The Village is served by public water supply from a well and a spring. Supply capacity of the spring varies from 0 to 0.9 mgd, dry weather to springtime, but the combined capacities of the two sources are adequate for Candor's needs at present. The Village does not have public sewers at this time, since individual wastewater systems adequately serve this area of well-drained soils.

Population is projected to increase at a moderate growth rate to 1,850 by the year 2020 and the wastewater flow for the community is projected to be approximately 0.21 mgd. The Tioga County Comprehensive Sewerage Study (TCCS) had estimated the wastewater flow to be 0.31 mgd by the year 2020. This higher wastewater flow projection could be attributed to expected higher growth rate and the inclusion of some portion of the Town of Candor outside the Village.

Village of Newark Valley

The east branch of Owego Creek divides the Village of Newark Valley, in the Town of Newark Valley. The major development of the Village is on the west bank of the Creek. The Village of Newark Valley is about 10 miles north of the Village of Owego and 13 miles northwest of the Village of Endicott. The community is essentially residential in nature with a small commercial center to serve the Village and agricultural community located on the West Branch of Owego Creek.

The Village has had a public water supply since 1904. Three wells serve the Village, and water quality in two of the wells is excellent.

The Village is served by individual home wastewater treatment systems at this time. The soils in the area are gravelly and well-drained because of its location in the Owego Creek Valley, and no known problems exist with this method of disposal.

The community will be generating wastewater flow at the rate of 0.26 mgd by the year 2020, based on an estimated population of 2,350. The TCCS Study had projected a higher wastewater flow of 0.34 mgd for the year 2020 based on an expected higher growth rate.

Village of Nichols

The Village of Nichols, in the Town of Nichols, is located on the south bank of the Susquehanna River and the west bank of Wappasening Creek. The Village is situated about 10 miles west of the Village of Owego and 10 miles east of the Village of Waverly, and is basically residential in nature.

The public water supply, since the early 1900's, has been managed by Nichols Water Works. Individual wastewater treatment systems (septic tanks) serve the area quite well.

Due to its strategic location from the Village of Owego and the Village of Waverly, and its close proximity to the Route 17 Expressway, the population is expected to double to 1,200 by 2020. The wastewater flow from the community is projected to be 0.13 mgd for the year 2020. The population projections derived by the TCCS Study and by the present study for the Village of Nichols are the same. The TCCS

Study investigated a 0.10 mgd extended aeration secondary treatment system for 1970, to be expanded to a capacity of 0.14 mgd in 1990 to serve until 2020.

Village of Spencer

The Village of Spencer, in the Town of Spencer, is located on the west bank of Catatonk Creek in the valley area. The Village is located in the northwest corner of Tioga County, about 8 miles east of the Village of Candor. The community is essentially residential in nature and has a small commercial center to serve the Village and surrounding agricultural community. Ithaca is about 17 miles north of the Village and Owego Village is about 18 miles southeast of the Village.

There is no public water or public sewer in the Village at this time. Individual wells provide water, and individual wastewater treatment systems dispose of the sewage.

Based on a projected population of 2,250 by the year 2020, the community will contribute approximately 0.25 mgd of wastewater. The TCCS Study had projected a slightly lower wastewater flow for the year 2020 (0.21 mgd).

Village of Waverly

The Village of Waverly, in the Town of Barton, is located in the Susquehanna Valley area, east of the Chemung River and west of the Cayuta Creek. The Village is located in the extreme southwesterly corner of Tioga County. The southern boundary of the Village is also the New York-Pennsylvania state line.

The community is residential with some commercial and industrial population, and is strongly influenced by the economy of the Boroughs of Athens, Sayre, and South Waverly, which are located adjacent to the Village in the Commonwealth Pennsylvania.

The Village has had a public water supply since 1900; one well and a reservoir supply water to the Village and the adjoining areas. The Village does not have any sewage treatment system at this time. The central portion of the Village and some commercial areas are sewered with old combined

sewers discharging untreated sewage to the Cayuta Creek. The Village had hired Nussbaumer and Clarke, Consulting Engineers, to design the sewage system for the Village and the adjacent area, and had filed for a construction grant application with the New York State Department of Health during the beginning of 1968. After an October 1968 meeting of Village officials with the Office of the New York State Department of Public Health, it was decided to reduce the scope of the project to serve only the presently sewered area, the schools, and the hospital in Phase I construction. Due to the unavailability of construction grant funding and low ranking of the Village project on the priority list, the Village project has not been funded as yet. However, a tentative construction grant was recently approved.

The State is considering increasing the existing design capacity of the project to include the adjoining areas to the Village (North Waverly and East Waverly) and fund the entire project under a single phase.

According to a population projection of 4,100 by 2020, the Village will contribute a wastewater flow of 0.45 mgd. The inclusion of adjoining areas will increase the wastewater flow by 0.11 mgd for a total of 0.56 mgd by 2020.

The TCCS Study had derived higher population projections for the area and investigated two alternative plans to accommodate a wastewater flow of 1.3 mgd to serve until 2020. One alternative plan was to construct a treatment system within the Village boundaries and discharge to Cayuta Creek. An advanced waste treatment plant was proposed in order to safeguard the water supply at Sayre water intake, downstream on the Susquehanna River. Another alternative was to join with Athens and Sayre, Pennsylvania, in a joint treatment facility. This plan would require an interceptor to transport sewage to the joint facility and added treatment capacity. This new plant would be located downstream from the Sayre water intake point and would need only secondary treatment.

EVALUATION OF TREATMENT PROCESSES FOR SMALL SCALE WASTE TREATMENT

This portion of the Chapter will examine and evaluate the technology and generalized economics associated with individual home waste treatment systems and small scale centralized collection and treatment systems. Small scale wastewater treatment systems, such as package sewage treatment plant and custom-made STP's will be considered for different levels of treatment to meet a range of effluent criteria.

The purpose of this section is not to recommend a single solution for the Outlying Communities. Rather, information is provided in order to form a basis for a cost-effectiveness analysis comparing treatment on an individual home basis to centralized collection and treatment.

The effluent criteria for a discharge to intermittent streams are very stringent and effluent quality must approach that of a relatively unpolluted stream. These effluent criteria for intermittent streams require high levels of treatment before a discharge could occur. Discharge to other streams are governed by the assimilative capacity of the stream, with a minimum requirement of secondary treatment, (i.e., higher than 85 percent removal efficiency of effluent biological oxygen demand (BOD) and suspended solids (SS) concentration; on a monthly average basis, less than 30 mg/l.) As mentioned previously, the national goal of "zero discharge" of pollutants would require even higher levels of treatment in the future.

INDIVIDUAL HOME WASTE TREATMENT SYSTEMS

The Erie County, Pennsylvania, Study by Quirk, Lawler, and Matuskey (1974), evaluated the technology and economics associated with individual home waste treatment systems. The standards, limitations, performance, and costs for such systems were investigated in the Erie County Study with reference to good, fair, and poor soil conditions. A septic tank system for a family of four was found to have a total annual cost of between \$100 per year in good soil and \$300 per year in poor soil. A review of the feasibility and economics for various alternatives and improvements to the septic tank found that, at that time, the only feasible basic treatment

system for an individual home is the septic tank. Some modifications to this traditional treatment system show promise, but will still depend on proper installation and maintenance for adequate performance. The necessity of cleaning and maintaining septic tanks regularly cannot be over-emphasized, as improper maintenance was found to be a predominant cause for system failures.

SMALL SCALE CENTRALIZED WASTEWATER COLLECTION AND TREATMENT SYSTEMS

The projected wastewater flows for the Outlying Communities in Broome and Tioga Counties, New York, (Table II-2), for the year 2020 ranged from 0.05 mgd to 0.26 mgd, with an exception for the Village of Waverly, for which the wastewater flow was projected as 0.45 mgd.

For average daily wastewater flows ranging from 0.02 to 0.08 million gallons, the factory-built package plants made from steel tanks are considered economical. However, for higher flows ranging from 0.10 mgd to 0.50 mgd, the custom made package plants built at site from poured-in-place concrete would be more economical because of their longer life expectancy.

The three treatment approaches considered for treating domestic wastes were biological, physical/chemical, and land treatment. Table II-3 presents the unit processes that are presently available in package form.

Various combinations of the unit processes can be used to meet given effluent criteria. Technical design and performance criteria for processes listed in Table II-3 are described in the following paragraphs.

Extended Aeration

Extended aeration is capable of producing 20 mg/l of SS and 15 mg/l of BOD under optimum conditions. Under normal operation, the plant will produce an effluent of less than 20 mg/l of BOD and less than 40 mg/l of SS. Thus, properly maintained and operated, this system should meet secondary treatment requirements.

The waste undergoes a significant period of aeration resulting in a lower loading rate. This long detention time in the

TABLE II-3

UNIT PROCESSES AVAILABLE AS PACKAGE PLANTS

Type	Unit Processes	Application
BIOLOGICAL	(1) Complete mix activated sludge with clarification	Biochemical oxygen demand and suspended solids reduction
	(2) Contact stabilization activated sludge with clarification	BOD and SS reduction
	(3) Extended aeration activated sludge with clarification	BOD and SS reduction plus ammonia reduction
	(4) Conventional activated sludge with clarification	BOD and SS reduction
	(5) Rotating biological filter *(Bio-Disc) with clarification*	BOD and SS reduction plus ammonia reduction
	(6) Nitrification	Ammonia nitrogen reduction
PHYSICAL/CHEMICAL	(1) Coagulation and settling	SS reduction
	(2) Activated carbon	BOD, SS, and PO_4 reduction
	(3) Filtration	Soluble organics reduction
	(4) Breakpoint Chlorination	Ammonia nitrogen reduction
	(5) Post Aeration	Increase dissolved oxygen
	(6) "Normal" Chlorination	Disinfection

extended aeration system results in a stable process with respect to waste variability. In addition, the long retention time causes the solids in the system to undergo some degree of endogenous respiration, resulting in lower amounts of sludge for disposal than in other activated sludge processes. The savings incurred by lower sludge production at lower flow rates is more significant than at higher flow rates because the increase in cost due to the larger tank size for higher flow rates is less significant.

Extended aeration does have the advantage of effecting ammonia nitrogen removal. Under optimum conditions, less than 2 mg/l of ammonia have been observed, and the effluent ammonia is normally less than 10 mg/l.

Nitrifying bacteria are extremely sensitive to temperature. Optimum temperatures for nitrification are betwween 28 to 32 degrees centigrade (C). Nitrification ceases below 5 degrees C. One method of overcoming low temperature effects is to increase the mixed liquor concentrations. A 40 percent increase in the mixed liquor volatile suspended solids (MLVSS) from 2500 to 3500 mg/l should increase the rate of nitrification by 25 to 30 percent. This effect can also be reduced by maintaining higher mixed liquor temperatures, by covering the aeration tank or by providing longer detention time (36 hours aeration).

Since the extended aeration process is a viable alternative as recommended in the Tioga County Comprehensive Sewerage Study, a more detailed discussion of design criteria and considerations are included. Many of the observations also apply to the completely mixed activated sludge process, discussed later in this Chapter.

General design parameters for the extended aeration process are given in Table II-4. Skimming facilities are required but should not be operated continuously. Continuous operation of a skimmer at a clarifier surface can cause vertical velocity gradients which can result in solids carryover. Scum problems can be aggravated by too much air. Scum can also be a source of odor if not disposed of properly, but this problem can be avoided by handling scum in conjunction with the excess activated sludge.

The shape and design of the aeration tank should maintain effective mixing, minimize dead spots, prevent the deposition of solids and prevent short circuiting. Standby blower units should be provided, either installed or as a shelf spare depending on the size of the system. The drop-off pipes in

the aeration tank should be easily removable, and should be equipped with individual shut-off valves.

The design of the final settling tanks is extremely critical. Current standards for New York State are given in Table II-5. Currently, most package plants can satisfy these settling rates.

Sludge recycle capacity should be based on a return rate of at least 100 percent of the average daily flow with a variable adjustment and control of the return rate. Airlift sludge return is preferred. Each hopper in the clarifier should have separate sludge removal equipment.

Scum skimming equipment should be provided and should operate intermittently. Froth and foam control equipment should be provided on all plants 0.10 mgd or over. Provisions should be made for hosing facilities to hose off the premises and any equipment. In addition, space should be provided to perform any routine test work. Flow from the plant should be indicated, recorded, and totaled with an appropriate device.

Sludge handling facilities should be provided on site for all plants over 0.10 mgd. Sludge handling may also be provided for smaller plants, depending on the frequency of collections. The sludge handling facilities should consist of an aerobic digestion system with a tank capacity of at least 25 percent of the daily flow rate. General design parameters for an aerobic digestion system are given in Table II-6.

The plant piping system should provide adequate flexibility to divert all or a portion of the return sludge to the aerobic digestion system or to the aeration tank. Sludge should be sent to the digestion system when the mixed liquor solids reach a high level, usually between 4,000 and 6,000 mg/l. The frequency of removal can vary from one every 2 to 3 weeks to once every 3 to 4 months.

Sludge should be collected from the aerobic digestion system when the tank is full. The sludge can either be spread on sludge drying beds or processed at one of the large county sewage treatment plants.

Disinfection will be required for all plants whether discharging effluent to intermittent streams or otherwise. The design criteria for the disinfection system should be as follows: (1) the contact chamber shall provide 15 minutes detention based on the maximum peak flow; (2) chlorine

TABLE II-4

EXTENDED AERATION PROCESS
GENERAL DESIGN PARAMETERS

Food to micro-organism ratio (F/M), lb BOD/lb MLVSS/day	0.05 -- 0.15
Volumetric Loading lb BOD/1000 cu ft/day	10 -- 25
Mixed liquor suspended solids mg/l	3000 -- 6000
Hydraulic detention time hours	18 -- 36
Recycle ratio	0.5 -- 1.5

TABLE II-5

EXTENDED AERATION PROCESS
SURFACE SETTLING RATES

Design Flow	Extended Aeration Surface Settling Rates gal/day/ft^2
0.0 to 0.05 mgd	300
0.05 to 0.15 mgd	300
Above 0.15 mgd	600

TABLE II-6

AEROBIC DIGESTION SYSTEM

GENERAL DESIGN PARAMETERS

Sludge residence time Days	12 -- 30
Solids loading lb vol. solids loaded/ft^3/day	0.1 -- 0.2
Oxygen required lb O_2/lb vol. solids destroyed	1.6 -- 2.2
Energy Requirements:	
Mechanical aeration, hp/1,000 cu ft	0.5 -- 1.5
Air mixing cfm/1,000 cu ft	20 -- 40
Dissolved oxygen level, mg/l	1 -- 3
Volatile solids reduction	30 -- 50 percent

feeders shall have a capacity of feeding at least 10 mg/l for the average design flow; and (3) the chlorine equipment shall be operable during the winter and summer months.

Effluents which are discharged to intermittent streams will require dissolved oxygen levels of 7.0 mg/l or greater. This can be accomplished through the use of a cascade aeration system or mechanical reaeration. At least 3 to 10 feet of head are generally required for gravity (cascade) aeration.

Complete Mix Activated Sludge

The complete mix activated sludge process is similar to that for extended aeration in that the waste undergoes screening, aeration, and settling with sludge recycle. The major difference is in the aeration tank volume which is significantly smaller than in extended aeration. The general design parameters for a complete mix activated sludge process are given in Table II-7.

With reference to its application, the following conclusions can be drawn about the complete mix activated sludge system: ( ) sludge produced, approximately 0.5 lb MLVSS/lb BOD, is greater than in extended aeration; (2) the processs is less amenable to influent load variations than is extended aeration; (3) under optimal operation, an effluent of 15 mg/l BOD and 20 mg/l SS can be met, but to ensure such quality on a regular basis, a filtration step should be included; (4) ammonia nitrogen removal is minimal; and (5) complete mix activated sludge is not recommended for use below 2000 pounds per day of BOD by 10 State Standards for the design of sewage works.

Contact Stabilization

The contact stabilization process is used when a large part of the BOD is present in suspended or colloidal form. The process is based on the high initial adsorptive removal of suspended and colloidal BOD by micro-organisms. The solids contact the waste in the solids contact tank for a relatively short period of time, ranging from 20 to 60 minutes. The solids are then separated from the waste in a clarifier and are sent to a reaeration tank where the solids are aerated to promote the stabilization and metabolism of the adsorbed colloidal and suspended BOD. This reaeration period can vary from 3 to 6 hours. The general design parameters can range as indicated in Table II-8.

TABLE II-7

COMPLETE MIX ACTIVATED SLUDGE PROCESS

GENERAL DESIGN PARAMETERS

Food to micro-organism ratio (F/M), lb BOD/lb MLVSS/day	0.2 -- 0.4
Volumetric loading lb BOD/1000 cu ft/day	50 -- 100
Mixed liquor suspended solids mg/l	2000 -- 5000
Hydraulic detention time hours	2 -- 6
Recycle ratio	.25 -- 1.0

This process is capable of producing an effluent quality of 20 mg/l SS and 15 mg/l BOD only under optimum loading conditions. As with the complete mix activated sludge process, limited nitrogen removal capabilities are available. This process is less stable than complete mix activated sludge at low flow volumes, since the small retention time in the contact tank makes the process very sensitive to waste load and volume changes. Since this process has no advantages over the completely mixed system, it was not considered further in this Study.

Rotating Biological Disk

This treatment unit consists of a series of plastic discs, mounted on a rotating shaft, so that the discs are partially submerged and partially exposed to air. Bacteria grow on the discs to provide assimilation of organic matter. The design parameters for the rotating biological disk process are shown in Table II-9.

The rotating biological disk will produce an effluent quality of 25 mg/l of SS and 18 mg/l BOD, under optimal conditions. A high degree of nitrification, producing less than 3 mg/l of ammonia, is possible by reduction in loading rate, i.e., an increase in discs provided. For BOD removal, a loading of 5-6 lbs BOD/day/1000 square feet of disc is practical, whereas loadings of 2-3 lbs BOD/day/1000 square feet are required for nitrification.

The rotating biological disk process is subject to operational problems (poor BOD and ammonia removals) caused by low temperature operations. These problems can be overcome by covering the reactor sections, which also minimizes odors. Adequate settling tanks must be provided to maintain effective treatment. The criteria given for extended aeration plants should suffice.

Skimming and sludge handling facilities for a rotating biological disk unit should be installed and operated according to the standards and criteria given for the extended aeration system.

The effluent quality from this system is slightly poorer than that for extended aeration, but with proper operation and maintenance, this system should be capable of meeting secondary treatment standards.

TABLE II-8

CONTACT STABILIZATION PROCESS

GENERAL DESIGN PARAMETERS

Food to micro-organism ratio lb BOD/lb MLVSS/day	0.2 -- 0.6
Volumetric Loading lb BOD/1000 cu ft/day	30 -- 80
Mixed liquor suspended solids in the contact unit, mg/l	1000 -- 3000
Mixed liquor solids in the reaeration tank, mg/l	4000 -- 10,000
Recycle ratio	0.25 -- 1.0

TABLE II-9

ROTATING BIOLOGICAL DISK PROCESS

GENERAL DESIGN PARAMETERS

Hydraulic loading rate gpd/ft^2 of disc	0.5 -- 2
Organic loading rate lb BOD/day/1000/ft^2 of disc	2 -- 6
Detention time minutes	50 -- 70
Peripheral shaft speed, fpm	4 -- 10
Number of shaft disk assemblies in series	4 -- 5
Secondary settling tank lb/ft^2/hr at peak flow	1.25 -- 1.6
Number of disks/shaft	40--60

Filtration

All of the processes discussed above require a filtration step to meet secondary treatment criteria under normal operating conditions.

Both rapid sand filters and multi-media filters are available in package units. Filter rates of between 2 and 15 gpm/square feet (on average daily flow basis) can be employed. On effluents which are stable, and have SS levels less than 30 mg/l, a rate of between 10 to 15 gpm/square feet can be used. However, for the plants considered herein, a rate of 4-5 gpm/square feet should be employed to assure dependable operation. Multi-media filtration offers the opportunity of utilizing the full bed depth to effect filtration, not merely the surface layer as in sand filtration. The multi-media filter has the coarse material, with a low specific gravity, at the top, and the finer materials, with higher specific gravities, at the bottom. The specific gravity differential prevents intermixing of the various media during backwashing. These filters are available from a number of manufacturers and can be engineered to backwash automatically. These filters can produce effluents of 1 to 5 mg/l SS in an extended aeration plant.

Physical/Chemical Treatment Processes

Physical/chemical treatment processes have gained a good deal of prominence within recent years as a result of increased effluent quality requirements. In the past, physical/chemical treatment has been regarded as a tertiary or advanced treatment process, which would follow normal biological secondary or advanced treatment. Recently, however, physical/chemical treatment has developed as an independent process to treat raw sewage.

There are two basic processes available for package physical/chemical treatment systems: systems employing powdered activated carbon and systems employing granular activated carbon.

The system employing powdered carbon contacts the raw waste with alum, powdered carbon, soda ash (for pH control), and a polyelectrolyte in a flocculation chamber. The waste is then settled, with the aid of settling tubes, and followed by multi-media filtration. The waste is then disinfected prior to discharge. The powdered carbon is used on a once through basis.

This system is capable of producing an effluent with a BOD of less than 15 mg/l, SS of less than 20 mg/l, and phosphorus of less than 1 mg/l. No ammonia removal is obtained. The system has the advantage of being unaffected by variations in waste load or volume. This particular physical/chemical process would not produce an effluent with a BOD of less than 5 mg/l for discharge to an intermittent stream.

In order to approach a BOD of 5 mg/l, this process would have to be preceded by a conventional activated sludge package plant. In this case, the BOD could be reduced to less than 5 mg/l, but at a substantial cost. Nitrogen removal could be added in the biologic system to effect ammonia removal.

A second system employs granular activated carbon. This system contacts the waste with ferric sulfate and soda ash for pH control in the flash mix chamber, followed by a flocculation tank. The waste is then settled with some of the sludge being recycled and the rest being sent to an aerobic digester. The clarified waste is then sent to a series of aerated upflow granular carbon columns. The upflow mode of operation prevents any clogging of the carbon bed, and, since the columns are aerated, some biological BOD removal is obtained, which serves to improve the efficiency of the carbon columns. The carbon capacity is improved from the traditional 0.1 pound of chemical oxygen demand (COD) removed per pound of carbon to between 0.5 to 1.0 pounds of COD removed per pound of carbon. This increased loading factor serves to improve the overall economics of the system.

The waste is filtered through a multi-media filter to remove any biological solids; then it is disinfected. This process is capable of producing an effluent of less than 5 mg/l BOD, less than 5 mg/l of SS, and less than 0.5 mg/l of phosphorus. For the ammonia nitrogen removal to meet intermittent stream standards, breakpoint chlorination of the effluent must be used (10 mg/l of chlorine is generally applied for each mg/l of ammonia to be removed.)

For the granular adsorption system, the carbon should be regenerated for the system to be economical. The amount of sludge produced from such a facility is large, resulting in greater sludge handling costs per gallon treated. The cost estimate, as with the biological treatment systems, has been made with the assumption that centralized regeneration is generally uneconomical at levels below 2000 pounds per day. A 0.10 mgd plant would use 600 pounds per day; thus multiple installations should be considered with a central regeneration facility.

Combinations

Combining the above mentioned processes in various manners, different types of treatment systems could be formulated to meet required effluent criteria. Table II-10 summarizes eight different schemes: six schemes (I-VI) to meet the the effluent criteria for discharge to intermittent streams, and two schemes (VII & VIII) to meet effluent criteria for discharge from secondary treatment systems. Schemes I through VI are tertiary treatment systems for high degrees (around 95 percent) of BOD, COD, SS, phosphorus, and NOD removal. They can also be considered to approach the national goal of zero discharge.

LAND APPLICATION SYSTEM

Another viable treatment alternative is a land application system. The performance and cost of land application in any region are dictated by soil types, depth to groundwater and climate, distance to suitable sites, elevation differences, and prior treatment efficiency.

The soils of Broome and Tioga Counties can be categorized under two broad headings. The Valley Soils (combination of Chenango, Tioga, and Howard associations) are level, well-drained, and overlie productive groundwater supplies. Near the urban areas, these soils have extensive residential development and in outlying areas, they constitute the area's best agricultural land. Although the soils themselves are condusive to land application of wastewater, they are generally highly developed, and the danger of contamination of water supplies and streams is significant. Accordingly, before considering the valley soils for land application, thorough analysis should be undertaken.

Most of the Bicounty Area is covered by upland soils of the Lordstown, Mardin, and Volusia associations. These soils are hilly, shallow, and poorly drained due to a dense soil layer or fragipan which lies close to the ground surface.

Residential development is sparse, and although the water table is within several feet of the surface for much of the year, the groundwater sees limited water supply use. Although the poor drainage and hilly nature of the upland soils as well as their shallow water table is unfavorable for land application, they are the only soils in the area for which land application can be considered feasible.

TABLE II-10

SUMMARY OF SMALL-SCALE CENTRALIZED WASTEWATER TREATMENT SCHEMES

Scheme No.	Process Description *
I	P/C Treatment + C-Columns + F + B-P Chlor + Dechlor + Re-Aera + Aero-Diges
II	A/S + P/C Treatment + F + B-P Chlor + Dechlor + Re-aera + Aero-Diges
III	A/S + P/C Treatment Bio-Reac + Re-Aera + Aero-Diges
IV	Ex-Aera(24 hrs) + P/C Treatment + B-P Chlor + Dechlor + Re-aera + Aero-Diges
V	Ex-Aera (36 hrs) + F + Re-aera + Aero-Diges
VI	Bio-Disc (1 gpd/ft^2) + F + Re-Aera + Aero-Diges
VII	Ex-Aera (24 hrs) + Aero-Diges
VIII	Bio-Disc (2 gpd/ft^2) + Aero-Diges

*Explanation of Abbreviations:

P/C Treatment: Physical/Chemical Treatment includes chemical coagulation and flocculation, pH control, and clarification.

C-Columns: Aerated upflow granular activated carbon columns.

F: Multimedia filtration.

B-P Chlor: Break-point chlorination.

Dechlor: Dechlorination after B-P chlorination.

Aero-Diges: Aerobic digestion for sludge handling.

Re-Aera: Re-aeration for higher dissolved oxygen contact in the effluent.

Ex-Aera: Extended aeration.

Bio-Reac: Biological reactor for nitrification.

Bio-Disc: A mode of biological treatment.

A/S: Activated sludge.

A final consideration for land application is the region's climate. The average frost-free season is approximately 150 days. Since freezing temperatures will interfere with equipment operation and result in ponding and runoff from application sites, the period of application would be limited to a maximum of six months (May through October).

A wide range of application rates have been reported for land disposal sites, with 2 in/week being the most common value. This rate would certainly be an upper limit for the poorly drained, moderate-to-steeply sloped upland soils. In order to prevent nitrogen from entering either groundwater or flowing streams, application rates would have to correspond to the nitrogen requirements of the vegetation growing on the disposal site. At 200 pounds/acre of nitrogen for either forest or grass, an application rate of 1.7 in/week over a 26 week period would be acceptable (see Chapter V of this Appendix for further details). This rate is used in subsequent estimates of land areas and costs.

COST ESTIMATIONS

Capital costs for the eight treatment schemes outlined in Table II-10 are plotted on Figure II-2. The capital cost estimates are based on vendor budget information (1973 basis) for packaged items, and estimates of installation cost, adjusted to ENR Index for December 1974.

Installation costs include site work, excavation, foundations, access, equipment placement, electrical hook-up, piping connections, and fencing. Outfall costs or running utilities to the site are not included, due to the dependence of these items on site characteristics. Also not included are sludge drying beds or an office building.

Figure II-2 also shows the capital cost estimates for extended aeration type secondary treatment systems proposed in Tioga County Comprehensive Sewerage Study (1970), updated to December 1974. The capital cost data given in TCCS Study are 40 to 55 percent higher than secondary treatment schemes VII and VIII. This may be attributed to the inclusion in TCCS Study of land costs, office building, utilities, outfall, and sludge drying beds. Figure II-3 shows the annual operations and maintenance (O&M) costs for the eight different treatment schemes. Operating costs include power, chemicals, and labor for both operating and maintenance. No allowance for material supply was in the maintenance

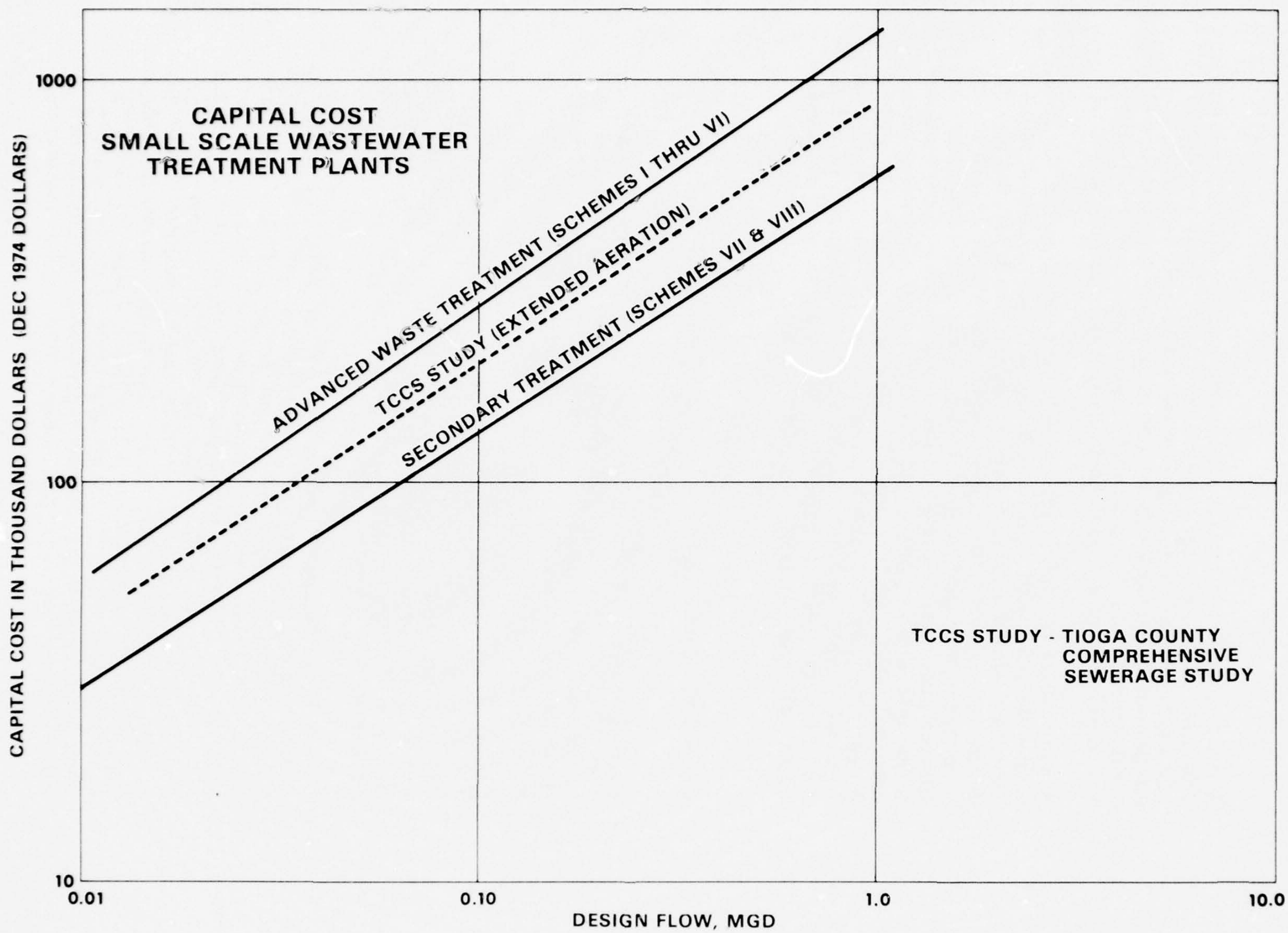

CAPITAL COST
SMALL SCALE WASTEWATER
TREATMENT PLANTS
ADVANCED WASTE TREATMENT (SCHEMES I THRU VI)
TCCS STUDY (EXTENDED AERATION)
SECONDARY TREATMENT (SCHEMES VII & VIII)
TCCS STUDY - TIOGA COUNTY
COMPREHENSIVE
SEWERAGE STUDY
CAPITAL COST IN THOUSAND DOLLARS (DEC 1974 DOLLARS)
1000
100
10
0.01
0.10
1.0
10.0
DESIGN FLOW, MGD

FIGURE II-2

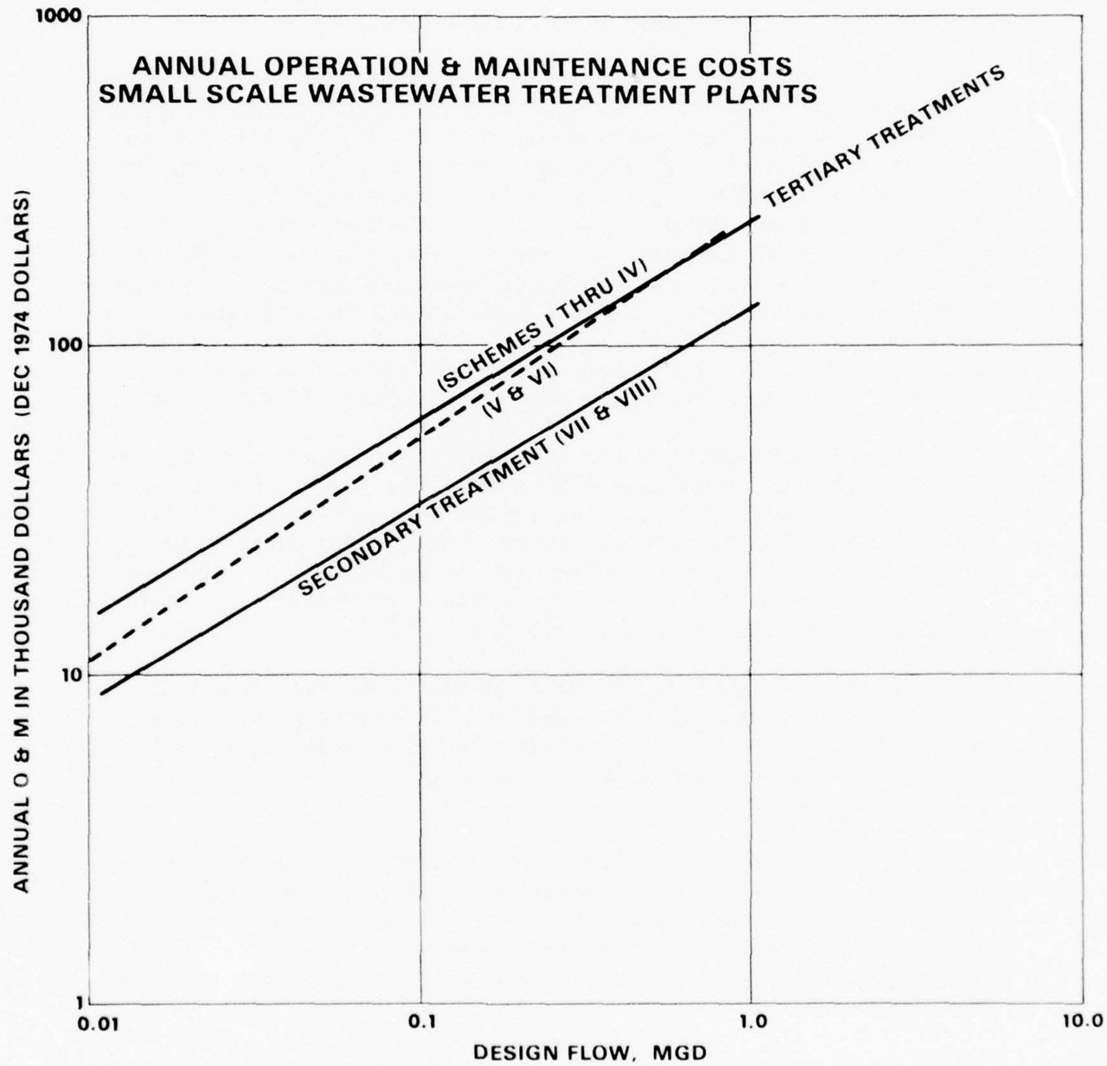

ANNUAL OPERATION & MAINTENANCE COSTS
SMALL SCALE WASTEWATER TREATMENT PLANTS
TERTIARY TREATMENTS
(SCHEMES I THRU IV)
(V & VI)
SECONDARY TREATMENT (VII & VIII)
ANNUAL O & M IN THOUSAND DOLLARS (DEC 1974 DOLLARS)
1000
100
10
1
0.01
0.1
1.0
10.0
DESIGN FLOW, MGD

FIGURE II-3

budget. Table II-11 summarizes the per capita and O&M costs at different flow rates for land application. On-site capital and O&M costs have been estimated based on C. E. Pound and R. W. Crites, "Wastewater Treatment and Reuse by Land Application" (US Environmental Protection Agency, August 1973). After comparing the costs for two application modes, spray irrigation and overland runoff, only spray irrigation was further considered here because of the significantly higher costs of overland flow.

Table II-12 summarizes the total costs for tertiary treatment Schemes I through VI with and without grants from Federal and State funds. For amortization cost, an interest rate of 6 1/8 percent and a 20 year life expectancy were assumed. In order to simplify the analysis for all cases, the flow to the plant was assumed to be the design average flow. For the case of grants, it was assumed to be 75 percent of the capital costs from Federal agencies and 12.5 percent from State agencies. With Federal and State grants, the total annual cost per capita varied from $37 to $85. However, without any grant, the total annual cost per capita varied from $55 to $125, an average increase of 47 percent.

Table II-13 summarizes the total costs for secondary treatment systems, Schemes VII and VIII, with and without Federal and State grants. The total annual cost per capita varied from $20 to $51 and from $28 to $70, respectively, with and without the grants from Federal and State agencies. The total annual cost per capita without the grant represents an increase of approximately 38 percent.

With grant availability, the total annual cost per capita for a 0.10 mgd tertiary system would be $66, whereas the secondary system of the same design flow rate would cost about $39 per year per capita. This represents an increase of $27 or about 69 percent.

Without the grant from Federal and State agencies, at an average design flow rate of 0.10 mgd, the secondary treatment would cost approximately $54 per capita per year, whereas the tertiary treatment system at the same design flow rate would cost approximately $96, an increase of about $42 (78 percent increase).

Table II-14 summarizes the costs for land application of secondary treated wastewater, with and without Federal and State grants. It is important to note that the costs in Table II-14 only include the land application portion of the treatment system; no costs are included for the conventional secondary treatment. (These costs are combined in

TABLE II-11

CAPITAL AND O&M COSTS FOR LAND APPLICATION SYSTEM*
(Spray Irrigation)

	Wastewater Flows, mgd			
	0.05	0.10	0.25	0.50
	Population			
	450	910	2270	4550
Land Requirements				
Disposal Area, acres	15.2	30.4	76.0	152.0
Buffer Area @ 20%	3.0	6.1	15.2	30.4
Storage Pond Area (6 months' storage pond of 20 ft. avg. depth)	1.4	2.8	7.0	14.0
TOTAL, Acres	19.6	39.3	98.2	196.4
Capital Costs				
Land @ $500/acre	$ 9,800	$ 19,700	$ 49,100	$ 98,200
Wastewater Distribution (pumping, pipes, sprinklers earthwork @ $2300 per disposal acre)	35,000	69,900	174,800	349,600
Storage Lagoon (Pond) (@ $16,000 per acre)	22,400	44,800	112,000	224,000
Transmission (@ 1 mile force main and a pump station)	21,600	32,900	59,600	95,200
SUBTOTAL	$ 88,800	$167,300	$395,500	$767,000
Engineering & Contingencies (@ 30 percent)	26,600	50,200	118,600	230,100
TOTAL CAPITAL COSTS	$115,400	$217,500	$514,100	$997,100
O&M Costs/Year				
Labor	$ 700	$ 1,500	$ 3,700	$ 7,500
Maintenance	3,500	7,000	17,500	35,000
Power	600	1,200	3,000	6,000
TOTAL O&M/YEAR	$ 4,800	$ 9,700	$ 24,200	$ 48,500

* All costs in this table are estimated for a "typical" land application system. Site specific information would be required before making a detailed cost estimate for any particular community.

TABLE II-12

TOTAL COSTS
SMALL SCALE TERTIARY TREATMENT SYSTEMS
(Schemes I through VI)

	Plant Size (MGD)			
	0.05	0.10	0.25	0.50
	Population			
	450	910	2270	4550
WITH GRANT				
Capital Costs[1]	223,600	353,600	663,000	1,059,500
Local Share[2] $	28,000	44,200	82,900	132,400
Annual Local Share[3] $/Yr	2,500	3,900	7,300	11,700
Operating Cost[4] $/Yr	36,200	56,000	100,600	158,000
Total Annual Cost $/Yr	38,700	59,900	107,900	169,700
Total Annual Cost $/1000 Gal	2.10	1.60	1.20	0.90
Total Annual Cost $/Capita	85.10	65.90	47.50	37.30
WITHOUT GRANT				
Capital Costs				
Local Share $	223,600	353,600	663,000	1,059,500
Annual Local Share[3] $/Yr	20,600	31,100	58,400	93,300
Operating Costs[4] $/Yr	36,200	56,000	100,600	158,000
Total Annual Cost $/Yr	56,800	87,100	159,000	251,300
Total Annual Cost $/1000 Gal	3.10	2.40	1.70	1.40
Total Annual Cost $/Capita	125.00	95.80	70.00	55.30

1. Includes 30% of Engineering and Contingencies cost.
2. Local share is calculated based on assumption that Federal and State aid is 75 percent and 12.5 percent, respectively.
3. Annual share is calculated on the basis of 6 1/8% interest rate and 20 years of life expectancy for equipment.
4. Wastewater flow contribution is assumed as 110 gallons per day per capita (gpdc).

TABLE II-13

TOTAL COSTS
SECONDARY TREATMENT SCHEMES
(Schemes VII and VIII)

	Plant Size (MGD)			
	0.05	0.01	0.25	0.50
	Population			
	450	910	2270	4550
WITH GRANT				
Capital Costs[1]	109,200	171,600	304,200	471,200
Local Share[2] $	13,600	21,400	38,000	58,900
Annual Local Share[3] $/Yr	1,200	1,900	3,300	5,200
Operating Cost $/Yr	22,000	33,500	58,000	87,500
Total Annual Cost $/Yr	23,200	35,400	61,300	92,700
Total Annual Cost $/1000 Gal	1.30	1.00	0.70	0.50
Total Annual Cost $/Capita[4]	51.00	39.00	27.00	20.40
WITHOUT GRANT				
Capita Costs				
Local Share $	109,200	171,600	304,200	471,200
Annual Local Share[3] $/Yr	9,600	15,100	26,800	41,500
Operation Cost $/Yr	22,000	33,500	58,000	87,500
Total Annual Cost $/Yr	31,600	48,600	84,800	129,000
Total Annual Cost $/1000 Gal	1.70	1.30	0.90	0.70
Total Annual Cost $/Capita[4]	70.00	53.50	37.30	28.40

1. Includes 30% of Engineering and Contingencies cost.
2. Local share is calculated based on assumption that Federal and State aid is 75 percent and 12.5 percent, respectively.
3. Amortization cost is calculated based on 6 1/8 percent interest rate and 20 years of life expectancy for equipment.
4. Wastewater flow contribution is assumed as 110 gallons per day capita (gpdc).

TABLE II-14

TOTAL COSTS
LAND APPLICATION SYSTEMS

	Plant Size (MGD)			
	0.05	0.01	0.25	0.50
	Population			
	450	910	2270	4550
WITH GRANT				
Capital Costs[1] $	115,400	217,500	514,100	997,100
Local Share[2] $	14,400	27,200	64,300	124,600
Annual Local Share[3] $/Yr	1,300	2,400	5,700	11,000
Operating Costs $/Yr	4,800	9,700	24,200	48,500
Total Annual Cost $/Yr	6,100	12,100	29,900	59,500
Total Annual Cost $/1000 Gal	.30	.30	.30	.30
Total Annual Cost $/Capita[4]	13.40	13.30	13.20	13.10
WITHOUT GRANT				
Capital Costs $				
Local Share $	115,400	217,500	514,100	997,100
Annual Local Share $/Yr	10,200	19,200	45,300	87,800
Operating Costs $/Yr	4,800	9,700	24,200	48,500
Total Annual Cost $/Yr	15,000	28,900	69,500	136,300
Total Annual Cost $/1000 Gal	.80	.80	.80	.70
Total Annual Cost $/Capita	33.00	31.80	30.60	30.00

1. Includes 30% of Engineering and Contingencies cost.
2. Local share is calculated based on assumption that Federal and State aid is 75 percent and 12.5 percent, respectively.
3. Amortization cost is calculated based on 6 1/8 percent interest rate and 20 years of life expectancy for equipment.
4. Wastewater flow contribution is assumed as 110 gallons per day capita (gpdc).

Table II-15). For the land application system, the total annual cost per capita remained fairly constant at about $13 and $31, respectively, with and without grants from the Federal and State agencies.

Table II-15 summarizes the total annual cost per 1,000 gallons per capita for septic tank, land application, secondary, secondary and land application, and tertiary systems. Secondary treatment followed by land application is a more viable economical solution than tertiary treatment. The comparison of total annual cost per capita for a septic tank system (assuming poor soil conditions) versus a secondary treatment system shows that, with grant availability, the total annual cost per capita for a secondary treatment system is less by approximately 32 percent at an average design flow rate of 0.05 mgd and substantially less (73 percent) for flow rates of 0.50 mgd. However, without grant availability, the total annual cost per capita for septic tank and secondary treatment systems are comparable (7% difference) at an average design flow of 0.05 mgd and less by 62 percent for secondary treatment systems for flows of 0.5 mgd.

Similar comparison of total annual cost per capita for a septic tank to a secondary system followed by land application treatment with an availability of Federal and State grant shows that the costs are comparable at an average design flow of 0.05 mgd (14% difference) and lower by 55 percent for the land application system for a flow rate of 0.50 mgd. With grant availability, even the total annual cost per capita for tertiary treatment becomes comparable to septic tank system at a design flow rate of 0.10 mgd (12% difference), and less by approximately 50 percent at a design flow rate of 0.50 mgd. Without grant availability, the total annual cost per capita for secondary followed by land application and tertiary treatment systems become comparable to septic tank systems at a design flow rate of 0.25 mgd but less by 22 to 26 percent at a higher flow rate of 0.50 mgd. However, a very noteworthly caution is that this total annual cost per capita does not include the cost associated with the collection system, such as household connections street laterals and portions of interceptor cost. This type of cost information is very site specific and should be estimated on a case by-case basis.

Despite these shortcomings, the cost information presented above can be used as input in a cost-effectiveness analysis for individual Outlying Communities in Broome and Tioga Counties. The purpose of presenting this data was to provide the input data to determine the relative economics of

TABLE II-15

SUMMARY OF TOTAL ANNUAL COSTS

Individual Home Septic Tank Treatment System

Type of Soils	Total Annual Cost ($/Capita)
Good	25.00
Poor	75.00

Secondary, Tertiary and Land Application Treatment Systems

Centralized Treatment

	Plant Size, mgd			
	0.05	0.10	0.25	0.50
	Population			
	450	910	2270	4550
WITH GRANT				
a. Only Land Application				
$/1000 Gallons	0.30	0.30	0.30	0.30
$/Capita	13.40	13.30	13.20	13.10
b. Secondary Treatment				
$/1000 Gallons	1.30	1.00	0.70	0.50
$/Capita	51.00	39.00	27.00	20.40
c. Secondary + Land Application				
$/1000 Gallons	1.60	1.30	1.00	0.80
$/Capita	64.40	52.30	40.20	33.50
d. Tertiary Treatment System				
$/1000 Gallons	2.10	1.60	1.20	0.90
$/Capita	85.10	65.90	47.50	37.30

TABLE II-15 (Continued)

Centralized Treatment

	Plant Size, mgd			
	0.05	0.10	0.25	0.50
	Population			
	450	910	2270	4550
WITHOUT GRANT				
a. Only Land Application				
$/1000 Gallons	0.80	0.80	0.80	0.70
$/Capita	33.00	31.80	30.60	30.00
b. Secondary Treatment				
$/1000 Gallons	1.70	1.30	0.90	0.70
$/Capita	70.00	53.50	37.30	28.40
c. Secondary + Land Application				
$/1000 Gallons	2.50	2.10	1.70	1.40
$/Capita	103.00	85.30	67.90	58.40
d. Tertiary Treatment				
$/1000 Gallons	3.10	2.40	1.70	1.40
$/Capita	125.00	95.80	70.00	55.30

NOTES:

1. All data updated to December 1974. Capital cost updated with ENR Index 2135. O&M cost updated with Consumer Index 161.

2. Amortization cost calculated using 6 1/8% interest rate and 20 years of life expectancy.

providing local, rather than regional, waste collection and treatment systems. These costs can also be used to assess the economic viability of improved septic tank systems in comparison to local or regional treatment systems, and compare the different treatment alternatives for a region using septic tanks.

No attempt has been made to recommend or specify a particular treatment alternative for each individual Outlying Community.

HYPOTHETICAL SMALL COMMUNITY SITUATION

The costs given in the previous section of this Chapter were for various methods of treatment only. In the practical case, particularly where government grants are available for capital costs of treatment works, the cost of the collection system is often the highest one paid by the individual user. This section will briefly present a hypothetical case of a small village in the Brome-Tioga area, and summarize the costs involved in sewering that area and treating its wastes.

The design size of the community was taken as 900-1000 persons, representative of mid-range of the village sizes involved. This population is not be the present one, but accounts for growth to a future design year, e.g., 1990-2000. For a per capita wastewater generation of 110 gallons per day, the design flow to the plant is thus 0.10 MGD.

The degree of required treatment is more difficult to typify. It appears that few, if any, of the villages are on intermittent streams, so that, effluent standards do not apply, except that as a minimum secondary treatment is required. The secondary level of treatment will be used in the hypothetical case.

To estimate the cost of a collection system, a population density of 5 persons per acre was chosen as representative of the small residential communities in the area. At this density, and four persons per home, the amount of collector pipe required should average about 120 feet per home. In addition, 75 feet of connector pipe would be required to carry wastes from the home to the street lateral.

It can be shown that, at a population of 900-1000 persons, minimum pipe size and grade requirements dictate that only 8-inch diameter pipe would be used. The hypothetical case assumes no unusual construction conditions for this pipe, the cost of which would be approximately $20 per lineal foot, including engineering and contingencies. It was further assumed that no lift stations would be required, either in the collection system or at the treatment plant, and no interceptor sewers would be required.

With these broad assumptions, the cost of the collection system is shown in Table II-16. With secondary treatment costs, from Table II-13, total cost to the user in the hypothetical village was computed as shown in Table II-17.

It can be seen that these costs are greater than the cost of septic tanks, even comparing septic tanks in poor soil conditions with collection and treatment with maximum government aid. There are several factors which should be pointed out which, when accounted for, would make this difference in cost even greater:

a. The villages in question are existing ones, with the residents having already paid for their septic tanks. Thus, for these persons, the real difference in cost is the total cost of the collection and treatment system, minus the cost of septic tank cleaning.

b. The centralized system assumed would not meet treatment standards when the national goal of zero discharge is converted to required effluent standards. Properly designed and maintained septic systems, on the other hand, approach this national goal more closely, although nitrogen removal is not great with such systems.

This discussion, although brief in nature, should assist in bringing into perspective the economic problems associated with small scale waste collection and treatment. The high costs involved emphasize the importance to a small community of fully documenting its need for a centralized system prior to undertaking such a project. Villages which experience only scattered problems with respect to septic tank failure should fully pursue the alternative of septic system improvement before deciding upon the centralized approach.

There are, however, situations in which the installation of a centralized system is nearly inevitable. For example, centralized treatment may be desirable in areas of high groundwater table, in areas with clay soils, or in areas with existing high density of development. Furthermore, in

TABLE II-16

COLLECTION SYSTEM--ANNUAL COST

			Per Home	Per Capita
Capital:	Collectors	120' x $20/LF =	$2,400	$600
	Connections	75' x $ 4/LF =	300	75
TOTAL CAPITAL			$2,700	$675
Annual Cost, 6 1/8 @ 20 years			240	60

TABLE II-17

SUMMARY OF TOTAL ANNUAL COSTS
HYPOTHETICAL COMMUNITY OF 900-1000 PERSONS

	Per Home	Per Capita
WITH GRANT		
Secondary Treatment	$156	$ 39
Collection System	240	60
TOTAL ANNUAL COST	$396	$ 99
Or Approximately	$400	$100
WITHOUT GRANT		
Secondary Treatment	$216	$ 54
Collection System	240	60
TOTAL ANNUAL COSTS	$456	$114
Or Approximately	$460	$110

areas with severe problems, where a centralized physical system may not be the best solution, an organized planning and execution effort by the community might be necessary to accomplish such solutions as septic tank improvement and maintenance.

The following section discusses the planning effort which should be performed by any village in assessing its need for a centralized treatment system or in examining methods to make more efficient use of its present system.

WASTEWATER MANAGEMENT PLANNING FOR OUTLYING COMMUNITIES

The first portion of this Chapter discussed the existing situation, in each of the Outlying Communities, with regard to wastewater management. In general, these communities are residential with a small commercial district to service surrounding rural and agricultural areas. They are small, with low densities of development, and are generally adequately served with septic tanks for sewage disposal. An exception is the Village of Waverly, which is by far the largest and most densely populated and which has a sewage disposal problem of concern to the Village and the NYSDEC. In addition, there are some localized problems in other communities, such as Whitney Point.

This portion of Chapter II will deal with wastewater management planning for a "typical" small community. This typical community is not meant to parallel precisely any community in the Broome-Tioga area, but the discussion will be in the context of the size of most, and will assume a low existing density of development, proximity to a stream or river, and existing sewage disposal by means of septic tanks.

It is emphasized again that this discussion is not meant to provide a solution for any existing community in Broome--Tioga Counties. Rather, its purpose is to set forth principles involved in planning for such communities, and to provide some insight into the processes which might be involved in developing centralized systems.

A rational approach to planning within the Outlying Communities could consist of the following steps:

1. Demonstrate need for action (define problems);

2. Establish criteria or objectives for project;

3. Establish broad alternatives to septic tank systems;

4. Develop preliminary designs for project alternatives;

5. Evaluate alternatives;

6. Revise steps 1, 2, 3, & 4, (if indicated by costs or impacts evaluated in Step 5); and

7. Recommend course of action.

A brief discussion of factors to be considered in each of the above planning steps follows.

STEP 1 -- DEMONSTRATE NEED FOR ACTION

Problem definition is an essential part of the planning process, since a proposed project with a poorly demonstrated need will receive neither financial support from the government nor popular support from the community. Need could fall into one or more of the following categories:

Public Health: Septic tank leachates could be reaching the surface of the land, streets, or surface waters, where there is a danger to human health, particularly to children who could be present. Groundwater contamination could also result.

Aesthetic: odors, visible contamination of land or water.

Other environmental damage: examples are contamination of surface or groundwater, which is not severe enough to be public health problems, but which violate legal or community standards. Septic tank pumping is often associated with environmental damage.

Economic: In certain cases, the economic burden of maintaining septic tanks to meet public health of other environmental standards is severe. Note that an economic burden can only be documented with reference to an alternative solution.

Community Desire: This could take the form of a community willing to promote industrial, commercial, or high density residential growth, which could not be served by septic tanks.

In examining the need for a project as demonstrated by the above categories, an important consideration to keep in mind is the scale or scope of the problem, particularly with regard to physical extent. In certain instances, a commercial district might be overloading its septic tanks, whereas the residential portion of the community is not. A project, therefore, does not have to sewer the residential district to solve the problem. Similarly, if only scattered residences are experiencing leaching problems, it may be that the design or maintenance of the individual systems, not local soils, are to blame. In such cases, locally enforced design and maintenance regulations might be the proper solution to the problem. In fact, the community itself could provide the maintenance service. High density residential development or industrial development can have their own private disposal system, even if a mechanical treatment plant is necessary. Although an industry might be induced to locate in a village with a centralized system, there are legal, technical, and economic constraints on industrial connections to municipal systems which often mean that such connections are as costly as separate treatment and disposal.

Wastewater management considerations should be an integral part of overall community planning. For example, a zoning plan, based on other considerations, which results in high density housing, may require a centralized wastewater treatment system. The cost of such a system should be considered in establishing the desired community growth patterns.

The remainder of this discussion will assume that the community has demonstrated a need for a centralized system. However, the planning steps, which are set in the context of planning a centralized system, also apply to pursuing alternatives within the basic context of septic tank systems. Alternative courses of action, such as zoning regulations, septic tank regulations, and community septic tank maintenance, can each be analyzed under the stepwise process discussed below as well as a centralized collection and treatment system.

STEP 2 -- ESTABLISH CRITERIA OR OBJECTIVES FOR PROJECT

The criteria or objectives for a project will be a combination of legal requirements and community's desires. Examples of legal criteria are: State effluent standards for discharge to intermittent streams; water quality criteria for discharging to continuously flowing surface waters; or national standards for minimum of secondary treatment by 1977, and best practicable waste treatment by 1983.

In addition to those legal standards, the planning process should also account for the national goal of zero discharge of contaminants to surface waters by 1985.

Community desires might, in some cases, go beyond legal standards. For example, a community may decide to provide greater protection for surface waters than that required by stream standards or to provide for recycling resources. On the other hand, a community objective could consist of a ceiling on per capita expenditure, which could eliminate certain alternative courses of action. Such community objectives could be in conflict with each other, a situation which would become apparent in the later stages of the planning process.

STEP 3 -- ESTABLISH BROAD ALTERNATIVES TO SEPTIC TANK SYSTEMS

Any centralized system would consist of the following basic elements: collection, treatment, liquid disposal, and sludge disposal. For each system element, there are alternatives which can be considered or eliminated, based on a rough knowledge of the scale of system involved, generalized costs, local site conditions, and project objectives. Examples are:

Collection Systems--whether or not to consider staging of system; whether to sewer certain areas at all; consider conventional gravity systems only, or include pressure sewer systems.

Treatment--pre-packaged or custom built; biologically oriented or physical/chemical; mechanically oriented or lagoon; capacity and efficiency staged in time or not; sludge treatment methods.

Liquid Disposal--nearby small stream or more remote large stream; to land, via irrigation, rapid infiltration, or overland flow.

Sludge Disposal--haul to large disposal sites outside community, or operate own facility; mechanical or land oriented drying; opportunity for recycle to community agriculture.

Unless local site conditions dictate otherwise, it is well to consider at least some widely varying alternatives, such as surface water discharge and land treatment of liquid effluent. The importance of future legal requirements and goals, e.g., zero discharge, must be emphasized in establishing system components for consideration.

STEP 4--PRELIMINARY DESIGNS FOR PROJECT ALTERNATIVES

Once broad alternatives have been established for each system element, these component alternatives can be combined to establish preliminary system designs. As a basis of design, population and sewage flows are projected to future years to allow for sizing of system elements. Based on those projections, staging of sewer and treatment plant capacities are estimated, and treatment levels for benchmark years can be determined.

Included in the systems design are not only the sizing of all capital works, but also operating requirements for each alternative, such as operating and maintenance labor, chemicals, replacement parts, power requirements, sludge quantities, and operating schedules for land irrigation. Items such as treatment plants and irrigation sites, should be site-specific, to allow precise estimates of costs for land foundation conditions and distance to disposal site.

STEP 5--EVALUATION OF ALTERNATIVES

The evaluation of alternatives is done under two major categories: economic and environmental. The economic evaluation has as its major purpose the determination of which alternative is the most cost-effective. The costeffective solution can be roughly defined as that alternative which accomplishes the criteria and objectives for the project at the least total cost. One way to measure the total cost, for comparison purposes, is to calculate the present worth of all capital, operation, and maintenance costs, initial and

future. State and Federal aid will be given only for the most cost-effective solution, regardless of the "after grant" cost to the system users unless adverse environmental impacts outweigh the cost-effectiveness of that alternative.

The environmental assessment of each alternative considers social and local economic impacts on the environment as well as the natural environment. Impacts on the natural environment can fall under numerous categories, such as surface water, groundwater, land, air, terrestrial ecology, and aquatic ecology. Each alternative will have some impact on each of these, and the environmental assessment is an attempt to both define these impacts in such a way that the most desirable alternative can be determined, and also to suggest means to mitigate or eliminate avoidable impacts. Short-term impacts are differentiated from long-term ones, and irretrievable commitments of resources are also defined.

In the socio-economic realm, attention must be paid to the local financial impact of each alternative, and the opinions of the community should be solicited and documented. Financial impact accrues to the system users due to payment for the sewer collection system, and due to the non-aided portions of treatment works including some capital and operation and maintenance costs. In cases where the cost of a centralized system is greater than the cost of individual septic systems, a loss of disposable income occurs, which can be significant in small communities, particularly to persons on fixed incomes.

STEP 6--RECONSIDER ALTERNATIVES AND/OR CRITERIA

Based on the evaluation of alternatives, it may become clear that the alternatives, or the objectives and criteria on which these alternatives are based, should be revised. In the actual planning process, the procedure in Steps 1 through 5 can be viewed as an iterative one, in which the entire process may be executed several times, with the degree of detail and precision increasing with each iteration.

One obvious cause for reconsideration of the assumptions is the cost and financial impact involved. A high cost may result in a re-expression of the need for a project, particularly if that need were based on desires or problems not widely prevalent, or if the desires were originally expressed without full knowledge of the implications involved.

Other factors leading to such a reconsideration might be unanticipated impacts on the natural environment or technical uncertainties of general alternatives applied to a specific case.

STEP 7--RECOMMEND AND IMPLEMENT PLAN OF ACTION

The net result of the process outlined in the above steps should be a single alternative which meets all legal criteria, is cost-effective, and attains the best balance of meeting community goals and avoiding adverse environmental impacts. This alternative then becomes the recommended plan of action.

Implementation of the plan should be carried out within the legal framework of the Village. There is an established procedure for implementing a plan within the requirements and guidelines of NYSDEC and EPA consisting of legal and technical standards and grant application procedures.

SUMMARY

Chapter II has sought to provide some basic information about wastewater management systems for the Outlying Communities in Broome and Tioga Counties. Existing systems were investigated and specific technical processes were proposed for consideration should a village desire a centralized wastewater treatment system. Also developed were annual costs for the average resident in a hypothetical community of about 1,000 people similar to most villages in the Bicounty Area. The last section then examined seven broad planning steps to be undertaken by any village considering a change or modifications to its present system.

It is emphasized again that the discussion in this Chapter was not meant to provide a solution for any community in Broome or Tioga Counties. Rather, its purpose was to set forth principles involved in planning, and to provide some insight into costs which might be involved in centralized wastewater treatment systems for such communities.

CHAPTER III

NON-POINT SOURCE POLLUTION

Non-point sources of water pollution are, by definition, wastes that enter a stream or lake by means of distributed runoff and seepage. The sources - such as agricultural, silvicultural, construction, or mining activities - are diffuse in nature and discharge polluting substances to the water via widely dispersed pathways. Because such pollution is hard to measure, circumstantial evidence must be used to infer the nature and extent of water degradation.

Urban stormwater and combined sewer overflows are also labeled as non-point sources of pollution in some literature. Because of their importance with regard to wastewater management opportunities for the Urban Study Area in Broome and Tioga Counties, New York, stormwater and overflows are considered separately in a detailed section of the Design and Cost Appendix. Otherwise, there is little evidence of widespread non-point source pollution in Broome and Tioga Counties.

NUTRIENT POLLUTION

Nutrient elements, chiefly nitrogen and phosphorus, are emitted from agricultural lands as well as forested rural lands. These elements are abundant in nature, and thus it is difficult to deduce their specific origin. Phosphorus is a pollutant of concern because of its role in eutrophication, and nitrogen likewise is involved in eutrophication processes. Ammonia, a reduced form of nitrogen, is toxic to aquatic life at high concentrations. Oxidized nitrogen, usually nitrate, is present in most waters, and can also be a direct threat to human health at higher concentrations.

The rates of nutrient emmission are greatest from lands managed for intensive production of either crops or livestock. About 17 percent and 27 percent of the lands in

Broome and Tioga Counties, respectively, are devoted to active agriculture. However, only a small percentage of these lands are used for concentrated agricultural practices. The New York State Census of Agriculture listed 22 dairy farms in the two counties with more than 100 cows in 1969. High intensity (heavily fertilized) cropland totals approximately 300 acres. Neither activity is of a sufficient level to constitute a major pollution source in the area.

This observation is supported by the results of the New York State nutrient sampling program upstream of the Urban Study Area at Stations A-2 and B-3 (See Figure III-1 and Table III-1). The sampling results of these stations was assumed to indicate characteristics of the rural areas of the Bicounty Area, exclusive of the effect of the Urban Study Area. Average nitrogen concentrations for Stations A-2 and B-3 are reported in Table III-2 as 0.9 mg/l for the Susquehanna River and 1.1 mg/l for the Chenango and Tioughnioga Rivers. Comparable phosphate-phosphorus concentrations are 0.07 and 0.10 mg/l, respectively. These concentrations are at levels normally associated with undisturbed or forested drainage areas. These "natural" or background pollution levels do, however, result in large mass flow rates, even upstream of the Urban Study Area. Utilizing average annual flows, the above concentrations would result in an average of 31,000 lb/day of nitrogen and 2600 lb/day of phosphorus at the confluence of the Susquehanna and Chenango Rivers in Binghamton. Nitrogen and phosphate concentrations downstream of the urban area near Owego Village show a decrease with increased river flow (SRBC Report, Nonpoint Source Pollution, Assessment of the Chemung and Susquehanna River Subbasins). This relationship indicates that point sources are the primary contributor of nitrogen and phosphorus.

SEDIMENT POLLUTION

Another source of non-point pollution is the combined process of erosion and sedimentation. Damage occurs at the source where soil is eroded and again where it is deposited as sediment. Some natural sedimentation is necessary to support plant and animal life, but accelerated erosion can upset the delicate balance with the potential for significant damage to the existing environment.

There are three major sources of erosion as described in the "Erosion and Sediment Inventory for New York State"

WATER QUALITY SAMPLING STATIONS

SEE TABLE III-1

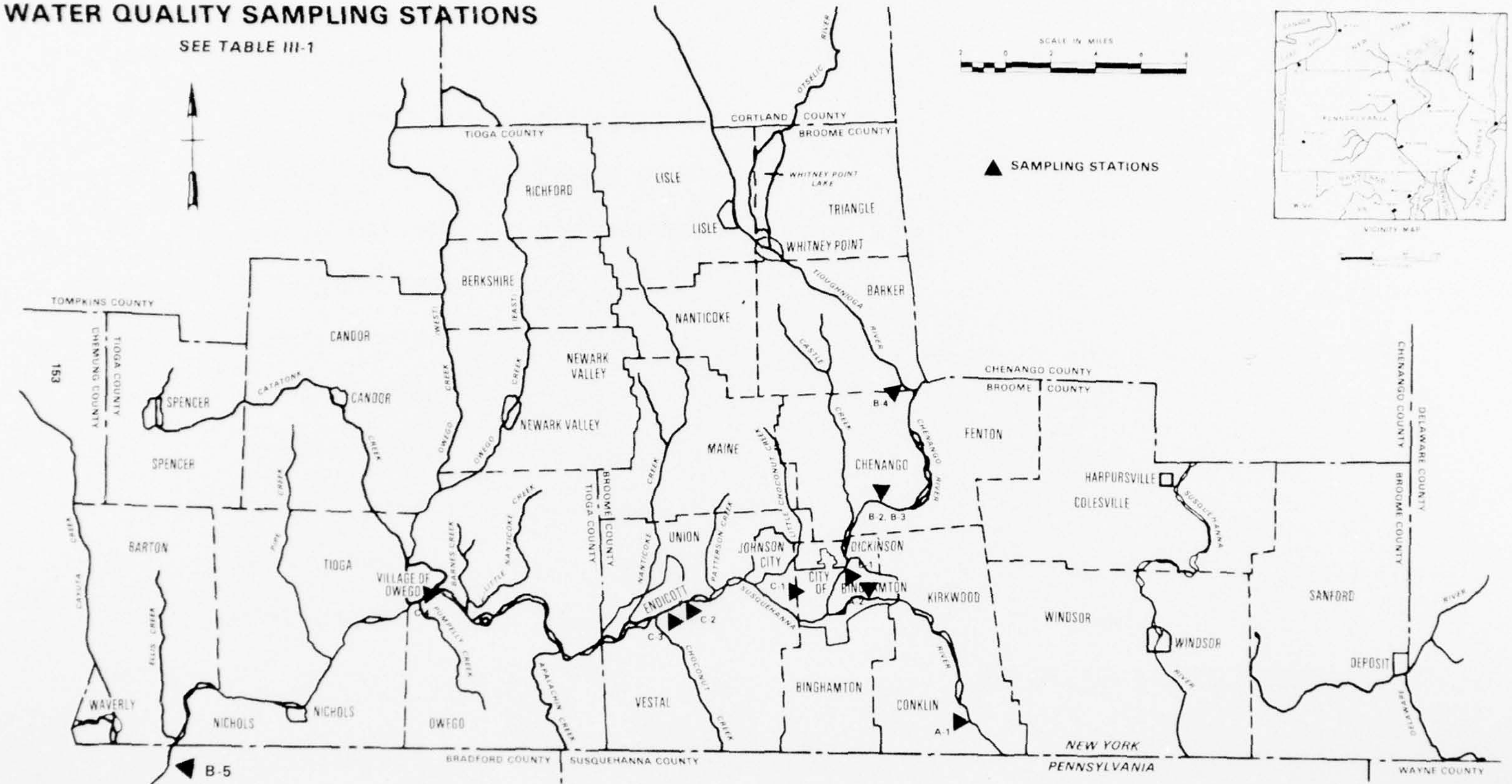


FIGURE III-1

TABLE III-1

WATER QUALITY SAMPLING STATIONS
(See Figure III-1)

Station	Description	Collection Agency*	Period of Record
A-1	Susquehanna River -- Conklin Forks	BCHD	1973--
A-2	Susquehanna River -- NYS #06-0002	NYSDEC	1953--1968
B-1	Chenango River -- Bevier Street	BCHD	1970--
B-2	Chenango River -- Route 12A	BCHD	1970--
B-3	Chenango River -- NYS #06-1091	NYSDEC	1964--1967
B-4	Tioughnioga River -- Chenango Forks	BCHD	1973--
B-5	Susquehanna River -- NYS #06-0015	NYSDEC	1968--
C-1	Susquehanna River -- Binghamton-Johnson City Line	BCHD	1970--
C-2	Susquehanna River -- Watson Bridge	BCHD	1970--
C-3	Susquehanna River -- NYS #06-0006	NYSDEC	1970--
C-4	Susquehanna River -- NYS #06-0020	NYSDEC	1968--

*BCHD--Broome County Health Department
NYSDEC--New York State Department of Environmental Conservation.

prepared by the U.S. Department of Agricultural, Soil Conservation Service. Sheet erosion accounts for most of the sediment reaching the State's waters. This process involves the removal of thin layers of soil over extensive areas and is most active on bare or unprotected soils, such as construction sites. The second significant source of sediment is streambank erosion when sides of channels and streambanks are washed away by river waters. Such slopes are difficult and expensive to stabilize and generally require a combination of structural measures and vegetative plantings. The third major source of erosion occurs along roadway cuts and embankments. Soil loss from such sources may vary from 1 to 30 tons per bank mile.

Suspended solids concentrations and turbidity levels reported in Table III-2 are not indicative of significant erosion problems in the Bicounty Area's waterways. Despite these low concentrations in the waterways, though, the widespread nature of the three erosion sources results in large mass erosion volumes. Table III-3 indicates the sediment from each type of erosion for both counties. Sheet erosion and streambank erosion rates are about average for New York State, but roadbank erosion is somewhat higher than the State average.

PREDICTION OF NON-POINT SOURCE POLLUTION

Planning for water quality management in watersheds can be effective only if the relationships involving inputs and outputs of various pollutants are understood, and if the effects of the pollutants on water quality can be reliably assessed. Further, it is essential that methods for predicting inputs and outputs be available to the planner. One such method for estimating nutrient balances is briefly described in the following text.

Within a specified region and time period, the basic types of movements of nutrients and solids can be measured. The basic types of movements are geologic, meteorologic, and biologic. On the input side, the geologic movements are additions of soil and rocks through land slides and earthquakes, plus additions of dissolved substances in flowing water. Meteorologic inputs are nutrients added in precipitation or in dust aerosols. The biologic inputs originate from all animal and plant sources including man. These inputs include human wastes, industrial wastes, commercial fertilizers, pesticides, and other wastes from agricultural production.

TABLE III-2

WATER QUALITY SAMPLING RESULTS--SUPPLEMENTAL PARAMETERS

	Total Suspended Solids (mg/1)	Total Nitrogen (mg/1)	Phosphate-Phosphorus (mg/1)	5-Day BOD (mg/1)	COD (mg/1)	Turbidity (Jackson Units)	Chlorides (mg/1)
Susquehanna Upstream							
A-1 1973	22	--	0.19	2.8	--	--	8.5
A-2 1953-68	25	0.9	0.07	1.6	9.5	23	7.3
Chenango River							
B-2 1971	15	--	--	2.6	--	--	14
1972	16	--	--	2.7	--	--	--
1973	24	--	0.16	2.9	--	--	13
B-3 1964-67	29	1.1	0.10	2.0*	14.5	13*	7.7
Susquehanna at Binghamton-Johnson City							
C-1 1971	32	--	--	3.4	--	--	--
C-2 1972	29	--	--	2.6	--	--	--
C-3 1973	25	--	0.19	3.0	--	--	9.1
Susquehanna at Vestal							
C-2 1971	25	--	--	4.0	--	--	--
C-2 1972	49	--	--	3.5	--	--	--
C-2 1973	33	--	0.23	3.7	--	--	11.3
C-3 1968-70	45	1.6	1.13	2.6	11.8	23	9.7
C-3 1971	31	1.6	1.17	3.7	15	10	12.2
C-3 1972	34	1.6	0.06	1.5	11.8	18	9.9
Susquehanna at Owego							
C-4 1971	63	1.5	0.23	3.6	16.7	14	16.0
C-4 1972	80	2.1	0.15	1.9	13.8	30	11.3
Susquehanna above Waverly							
B-5 1968-70	38	1.5	0.14	2.4	13.4	26	10.0
B-5 1971	30	1.5	0.20	2.6	12.9	14	10.3
B-5 1972	40	1.4	0.11	1.8	9.5	19	8.8

*Single sample.

TABLE III-3*

SOIL LOSSES IN THE BICOUNTY AREA

TYPE OF EROSION	BROOME COUNTY	TIOGA COUNTY	TOTAL	AVERAGE BICOUNTY RATE OF SOIL LOSS
Sheet				
Total Acres	443,164	332,583	775,747	1.3 tons/acre/year
Tons Per Year	565,546	443,368	1,008,914	
Streambank				
Total Bank Miles	2,184	1,848	4,032	50.5 tons/bankmile/year
Tons Per Year	124,057	79,464	203,521	
Roadbank				
Total Bank Miles	1,420	2,024	3,444	98.0 tons/bankmile/year
Tons Per Year	137,178	200,376	337,554	
Total				
Tons Per Year	826,781	723,208	1,549,989	

* Information derived from "Erosion and Sediment Inventory for New York State," U.S. Department of Agriculture, Soil Conservation Service. March 1975.

On the output side, the same basic types of movements occur. The flow of water from the region removes nutrients and solids. The nutrients removed by the wind are the meteorologic outputs. The biologic output would be those nutrients removed as harvested crops.

Within the region, there are interrelationships between the soil, available nutrients, and biota, the organic matter, and the atmosphere. The regional ecosystem is related to the atmosphere through the process of nitrogen fixation and denitrification in the nitrogen cycle.

With farm nutrient budgets, quantification of the above relationships for a regional ecosystem can be performed. Considering first the nutrients added to increase agricultural production, the analyst must determine the acreage of each crop in production. Given the acreage information, the analyst will have to ascertain the rates of application per acre for fertilizer, lime, and pesticides to each crop. It is necessary to ascertain the total quality of nutrients added to the soil.

The levels of nutrients removed from the soil as crop production is the next consideration. The acreage information utilized earlier is representative assuming that the harvested acreage equals the fertilized acreage. From a calculative viewpoint, the yield of each crop is the respective total crop yield. Multiplying the total yield for each crop by the respective content of each nutrient per unit of yield gives the total amount of each nutrient removed from the soil as crop production after adjustment for the level of nitrogen fixation by legumes.

The level of nutrients lost from the soil because of leaching or percolation must also be determined. This type of information requires technical soil research utilizing a lysimeter. The actual calculation is made by multiplying the rate of percolation for each type of vegetative cover by the respective acreage and then summing these products. The final consideration is the amount of nutrients added as meteorological inputs, precipitation and dust aerosols. The effect of wind action is virtually impossible to measure. The amount of nutrients added as precipitation can be determined through multiplying the nutrients added per acre by the total acres in the region. Totaling the nutrient inputs and outputs then yields the overall credit or debit to the area's nutrient budget.

SUMMARY

The factors of climate, soil conditions, topography, land use, watershed management practices, and man's activities all interact to produce non-point source pollution reaching streams and lakes by distributed runoff and seepage. Because of its diverse nature, non-point water pollution cannot be either easily measured or easily controlled. Based on limited data, the concentrations of non-point source pollutants in the waterways of Broome and Tioga Counties were found to be only slightly above the normal background conditions ordinarily expected in an area such as the Southern Tier.

CHAPTER IV

RIVER-ORIENTED RECREATION AND WASTEWATER MANAGEMENT PLANS

Because of the intense interest in the Riverbanks Improvement Program associated with the Susquehanna and Chenango Rivers in the Bicounty Area, a separate chapter of this Appendix is devoted to an analysis of river-oriented recreational potential associated with various wastewater management plans. The first section briefly describes the historical importance of the river system as a recreational attraction while the second section investigates existing recreational activities along the rivers. Future plans for water-based recreation are discussed in the third section, and the fourth section assesses the impacts of various wastewater management plans on river-oriented recreation.

HISTORICAL SIGNIFICANCE

The Susquehanna River and its tributaries were a major focal point of the early settlements and development of the Susquehanna River Valley. In the late nineteenth century, Hiawatha Island was a major resort area of the Susquehanna River with its hotel, bowling alleys, a dance pavilion, and summer house. Two steamboats were used to transport people to the attractions of the island. Fishing in the rivers and streams for trout, shad, and other fish in the late eighteenth and early nineteenth centuries was not so much a recreational activity as it was a necessity for supplementing food supplies. (A more complete description of the historical significance of the Bicounty Area and its local historic and prehistoric sites is given in the "Cultural Resources Reconnaissance Report" presented in Chapter VIII of this Appendix.) Man-made alterations to the river system including the construction of dams along the rivers,

the discharge of municipal and industrial wastewaters, and the influence of urban runoff have been important factors in the declining recreational use of the river system in the twentieth century.

EXISTING RIVER-ORIENTED RECREATION

EXISTING RIVER PARKS

Approximately 20 parks, of various sizes and with a variety of available facilities, are found adjacent to the Susquehanna River between Owego Village and the Town of Kirkwood, and along the Chenango River to its confluence with the Tioughnioga River. Figure IV-1 shows the approximate location of these river parks and Table IV-1 describes each of the numbered parks in Figure IV-1 as to their location, acreage, and available facilities.

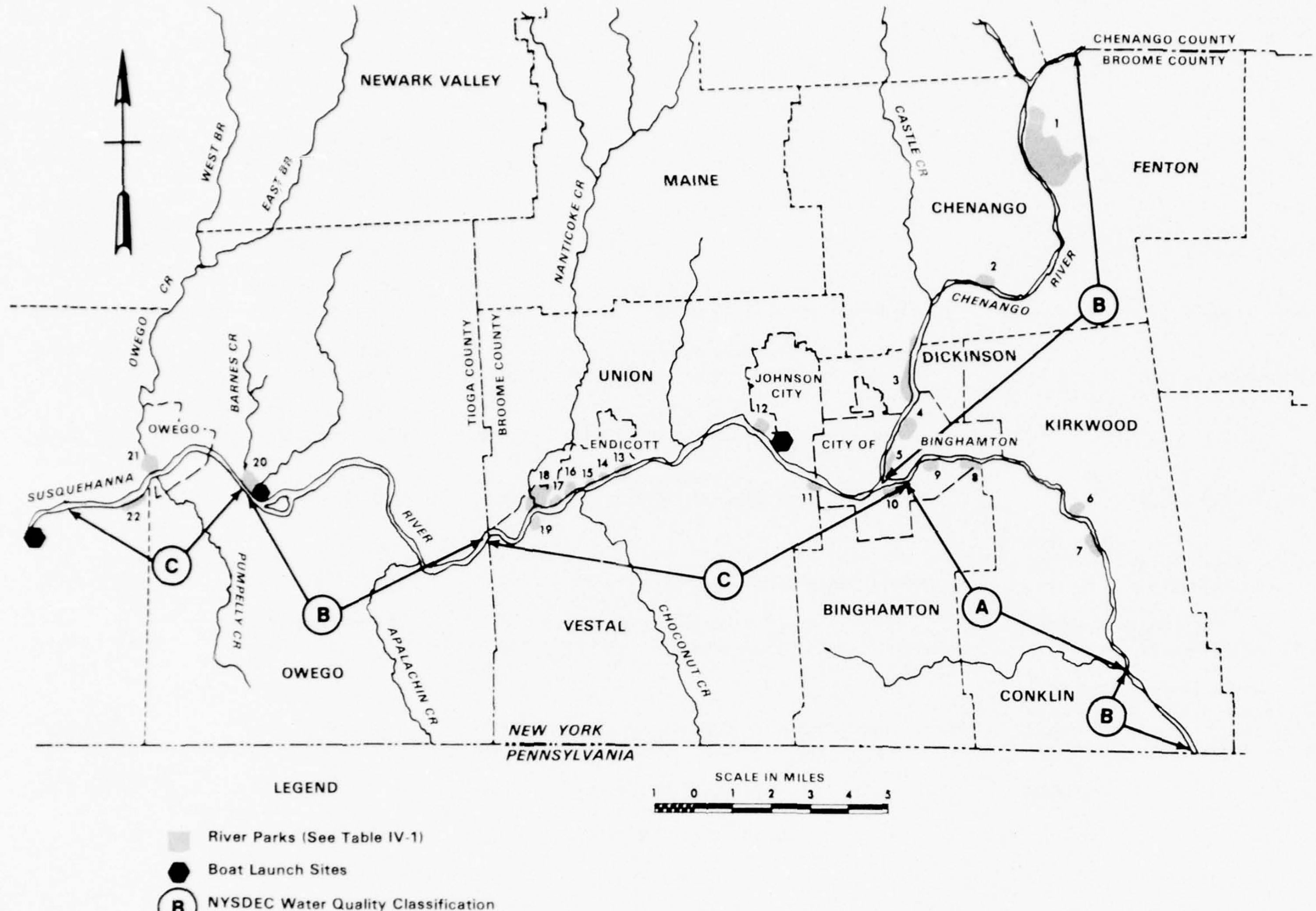
Attendance records for the river parks, except for Chenango Valley State Park, were unavailable. Furthermore, statistics concerning the extent of participation in any particular activity, e.g., boating, swimming, bicycling, within the river parks were also not available.

Except for such passive activities as sitting and viewing the rivers, the recreational activities of the river parks are not oriented toward direct use of the rivers as a recreational resource. Where swimming facilities are provided at river parks, swimming activities are carried on in pools or available park lakes.

SECONDARY CONTACT RECREATION

Secondary water contact recreation includes those activities where there is little probability of significant water contact or water ingestion and includes such activities as boating and fishing.

Boating, canoeing, and similar secondary contact recreation do occur on the Susquehanna and Chenango Rivers. Three public boat launch sites are located on the Susquehanna: in



EXISTING RIVER PARKS

FIGURE IV-1

TABLE IV-1

EXISTING RIVER PARKS

Park Name (#)	Location	Acreage	Facilities Available	Comments
Chenango Valley State Park (1)	NY Route 369 Town of Fenton	1500	Picnicking, lake swimming, lake boating, golfing, camping, fishing, snowmobiling.	Swimming is restricted to the Park's two lakes. Some fishing and boating occurs within the adjacent Chenango River.
Hyder Park (2)	Morningside Heights Town of Chenango	10	Playground, basketball, Little League baseball, baseball.	No primary or secondary river contact recreation.
Route 81 River Park (Unnamed) (3)	Route 81, Town of Dickinson	80	Scenic walkways, picnicking, bicycling.	Presently under development. No river contact recreation planned.
Stow Park (4)	Stow Flats, City of Binghamton	8.5	Playground, pool swimming, Little League baseball.	No river contact recreation.
Tyler Park (5)	Wall Street, City of Binghamton	0.12	Benches for resting and viewing.	
Kirkwood Valley Park (6)	Five Mile Point Town of Kirkwood	7.0	Playground, pool swimming, baseball, Little League baseball, ice skating.	No river contact recreation.
Town Park (7)	Conklin Road, Town of Conklin	8	Playground, pool swimming, basketball, ice skating, picnicking.	No river contact recreation.
Holmes Crossing Playground (8) (Sandy Beach)	Holmes Crossing City of Binghamton	15.3	Playground.	Former river swimming area, now playground.
Susquehanna Children's Home (9)	Homer Street City of Binghamton	15		No water contact.

TABLE IV-1 (Cont'd)

Park Name (#)	Location	Acreage	Facilities Available	Comments
South Side Park (10)	Conklin Avenue City of Binghamton	7.5	Benches.	View of river blocked by flood wall
City Line Park (11)	Vestal Parkway East - Town of Vestal	.83	Playground; picnicking.	No river contact recreation.
Westover Park (12)	Onondaga Street Town of Union	13	Baseball; playground; picnicking.	No river contact recreation.
Riverview Park (13)	Riverview Drive Village of Endicott	3.43	Picnicking.	No river contact recreation.
Union Park (14)	River Terrace Village of Endicott	18.5	Playground; baseball.	Now school athletic field.
Mersereau Park (15)	Mersereau Avenue Village of Endicott	12	Playground, baseball.	No river contact recreation.
Roundhill Park (16)	Edward Street Village of Endicott	33	Walkways and scenic view	No river contact recreation.
Grippen Park (17)	Grippen Avenue Village of Endicott	22.34	Indoor-outdoor ice-skating	No river contact recreation.
En-Joie Golf Course (18)	Main Street Village of Endicott	149.42	Golf course.	No river contact recreation.
Castle Gardens Park (19)	North Road Town of Vestal	3.21	Playground, basketball, baseball, softball, picnicking.	No river contact.

TABLE IV-1 (Cont'd)

Park Name	Location	Acreage	Facilities Available	Comments
The Hickories (20)	Route 17C, Town of Owego	112	Picnicking, athletic fields, boat launch.	No primary river contact recreation. Has existing boat launch to Susquehanna River.
Marvin Park & Ball field (21)	Village of Owego	25	County fairgrounds, playground, ball fields, pool swimming.	No river contact recreation.
Route 17 Rest Area (22)	Route 17, Town of Nichols		Rest stop and view of river.	

Johnson City; in Hickories Park (Town of Owego), and in the Town of Nichols to the west of the Village of Owego. These public boat launch sites are indicated on Figure IV-1. Some area homeowners with riverfront lots have private boat moorings; however, the location and number of such private sites was not documented. Estimates of participation in boating activities within the Study Area also were unavailable.

Warmwater sport fishing for smallmouth bass and walleye occurs within the Susquehanna and Chenango Rivers in the Bicounty Area. Sports news articles in the local papers (The Press and The Sun Bulletin, Binghamton, New York), make references to smallmouth bass and walleye fishing within the Susquehanna River near low dams and pipeline crossings of the river.

PRIMARY CONTACT RECREATION

Primary water contact recreatiion includes activities such as swimming, diving, and water skiing that involve significant water ingestion risks. Neither Broome nor Tioga Counties have any sanctioned river swimming areas at the present even though a number of public parks are adjacent to the Susquehanna and Chenango Rivers. Swimming activities within Chenango Valley State Park, adjoining the Chenango River, are limited to the lake areas within the Park.

The Broome County Department of Parks and Recreation, the City of Binghamton Parks Department and the Tioga County Sanitarian have indicated that unsupervised swimming within the Susquehanna River probably does occur, especially in those reaches of the river where there are privately owned river front lots. A private camp operated by the Binghamton Psychiatric Center uses the north shore of the Susquehanna River, near the eastern boundary of the City of Binghamton, for swimming activities. However, there were no statistics available as to the extent of any river-oriented swimming, either supervised or unsupervised.

Prior to 1972, the City of Binghamton operated a river oriented swimming area known as Sandy Beach. This beach, located on the southern shore of the Susquehanna River, at Holmes Crossing near the eastern boundary of the City of Binghamton, was officially closed to swimming at the end of the summer season in 1971. The reasons given for the

closing of the beach included: possible health hazards; rocky bottom and shore unsuitable for swimming and on-shore activities; life-guarding the swimming area was difficult; and the current was too swift for safe swimming.

PRESENT PROBLEMS OF RIVER-ORIENTED RECREATION

Several problems exist within Broome and Tioga Counties which limit the use of the river system for both primary and secondary contact river-oriented recreation. In conversations with the park departments, sanitarians, and sportsmen's associations, the following points were mentioned as being the major problems hindering river-oriented recreation. (The following list of problems does not indicate order of importance, nor magnitude of the problem).

a. Limited access to the river--much private ownership of river-front land; obstructions such as highways and railroads; flood prevention dikes; limited or no parking areas near rivers.

b. Pollution--river was said to be "dirty", "smelly", or a "health hazard" at certain times of the year.

c. River flow--depending on the desired activity, the river flow was mentioned as being either too slow (hindering fishing) or too fast (hindering swimming).

d. Obstructions in the river--dams along the river and pipe line crossings of the rivers have been dangerous obstacles to boaters and canoers, although fishing is said to be good at such dams and pipeline crossings.

e. Economics--costs involved in the construction, maintenance and operation (life guards, sanitary analyses, etc.) of sanctioned river-oriented recreation were felt to be prohibitive.

f. Other--rocky river bottom and shoreline in some areas were not conducive for swimming or shoreline beach activities.

STATE PLANS

The New York State Department of Transportation (DOT) is presently developing the land bounded by Route 81 and the Chenango River between the City of Binghamton and Nimmonsburg in the Town of Dickinson a park facility. After the completion of the park, the operation and maintenance of the park will be the responsibility of the Broome County Department of Parks and Recreation. The Commissioner of Parks and Recreation in Broome County has indicated that the Route 81 River Park will be primarily a passive recreation area, emphasizing such activities as picnicking, walking, and bicycling. There are no primary or secondary water-oriented activities planned for the facility.

Additionally, the DOT is attempting to open up areas along its right-of-way as parking areas for fishermen who use the Susquehanna River. For example, the Route 17 rest area just west of the Village of Owego is available as a parking area for fishermen who use the Susquehanna River.

In addition to the developed lands belonging to the Chenango Valley State Park in the Town of Fenton, the State also owns acreage adjacent to the existing park and the Chenango River. However, there are no plans for recreational development of these additional lands in the near future.

BICOUNTY PLANS

As part of the Southern Tier East Regional Plan for Broome and Tioga Counties, the Riverbanks Improvement Program emphasizes the potentials of the Susquehanna River system for recreation and open space. The Riverbanks Improvement Program identifies the Susquehanna River and the Chenango River as the most important scenic and recreational resources of the region; and, as such, a primary goal of the Program is to preserve and enhance the quality of these waterways. Through a system of small and large parks, conservation areas and strip connections between parks, the Program would maximize the recreational and aesthetic attributes of the area's waterways. Table IV-2

lists the Program's proposals and Figure IV-2 shows the location of these proposals. The Program does not have any site-specific information as to other secondary (fishing) or primary (swimming) river-oriented recreational areas.

COUNTY PLANS

Broome County is attempting to implement the goals of the Southern Tier East Regional Riverbanks Improvement Program via gradual acquisition of various riverbank sites. Efforts of Broome County have involved the acquisition of six riverbank sites located from the Broome-Tioga County line to slightly upstream of the Route 17 crossing of the Susquehanna River near the Town of Union. Acquisition and/or development of riverbank recreation and open space areas in the future would proceed in an easterly direction, from the present acquisition sites, upstream along the Susquehanna and Chenango Rivers. As mentioned previously, operation and maintenance of the Route 81 River Park will be under the jurisdiction of Broome County. Present plans for riverbank recreational areas do not include primary river-oriented recreation.

To date, Tioga County has not acquired any riverbank sites for implementing the goals of the Southern Tier East Regional Riverbanks Improvement Program.

LOCAL PLANS

Some local (town, city, village) efforts are underway or are planned to implement the goals of the Southern Tier East Regional Riverbanks Plan. However, use of the rivers for primary water contact recreation is not foreseen by any community.

In the Comprehensive Plan: Town of Kirkwood, two recreational areas along the Susquehanna River are proposed. One park facility is proposed in the vicinity of the confluence of Stanley Hollow Creek and the Susquehanna River. The second proposed facility is a River Park near Kirkwood.

The City of Binghamton Department of Parks has suggested that Sandy Beach, formerly a swimming area, may be

TABLE IV-2
RIVERBANKS IMPROVEMENT PROGRAM PROPOSALS (EXCLUDING STRIP CONNECTIONS AND CONSERVATION AREAS)

Name of Facility	Location: Mile-point	Location: Com-munity	Open Space Type	Level of Develop-ment	Jurisdictional Responsibility	Special Features	Pri-ority**
Cannon-hole Park	T-24	Nichols (T)	basic park	minimal	Tioga County	Complements riverside development on right bank.	II
South Barton Park	T-23	Nichols (T)	special facility	minimal	Nichols (T)	Campsite; central feature of concentration area and strip connection.	II
Barton Park	T-23	Nichols (T)	basic park and special facility	minimal	N.Y. State and Tioga County		I
Asbury Church Park	T-22	Nichols (T)	special facility	minimal	Nichols (T)	Boat launch.	II
Smithboro Park	T-20	Tioga (T)	basic park and special facility	minimal	Tioga County	Boat launch; provides terminus for strip connection.	I
Hooper Valley Park	T-19	Nichols (T)	special facility	minimal	Nichols (T)	Campsite; major feature of conservation area and strip connection.	III

** I. Within the time span of the current 6 year Capital Improvement Schedule for the Riverbanks Improvement Program.
II. By 1985.
III. By 1995.

TABLE IV-2 (Cont'd)

Name of Facility	Location Mile-Point	Location Com-munity	Open Space Type	Level of Develop-ment	Jurisdictional Responsibility	Special Features	Pri-ority
Bailey's Eddy Park	T-18	Nichols (T)	basic park	minimal	Nichols (T)	Capitalizes on existing park, boat launch and proposed conservation area.	II
South Lounsberry Park	T-17	Nichols (T)	basic park	minimal	Tioga County	Terminus of strip connection.	II
Tioga Center Park	T-16	Tioga (T)	basic park and special facility	minimal	Tioga County	Campsite and park provide focal point for strip connection and counterpoint for Lounsberry boat launch.	II
Lounsberry Church Park	T-15	Nichols (T)	intermediate park & special facility	moderate	Tioga County		
Horton Crossing Park	T-14	Nichols (T)	special facility	minimal	Nichols (T)	Boat launch provides focal point of strip connection.	II
Tioga Airstrip Park	T-13	Tioga (T)	special facility	minimal	Tioga (T)	Campsite integrated with strip connection and conservation area.	III
Owego Creek Park	T-12	Owego (V)	basic park	minimal	Owego (V)	Anchors existing park at north end of strip connection along Owego Creek and provides focal point for major conservation area.	I

TABLE IV-2 (Cont'd)

Name of Facility	Location Mile-point	Community	Open Space Type	Level of Develop-ment	Jurisdictional Responsibility	Special Features	Pri-ority
Pumpelly Park	T-11	Owego (V)	special facility	minimal	Owego (V)	Campsite integrated with major park development on both river-banks.	II
Village Line Park	T-10	Owego (V)	special facility	minimal	Owego (V)	Boat launch provides focal point for strip connection and major park facilities to east and west.	II
Hickories Park Ex-tension	T-8	Owego (T)	intensive use park	full	Tioga County	Extension will capitalize on existing park facilities and enhance them; represents the beginnings of the urbanized park system.	II
Hiawatha Island Park	T-7	Owego (T)	special facility	minimal	Owego (T)	Campsite and conservation area complement Hickories Park Exten-sion and capitalize in historic natural features.	II
River Road Park No. 1	T-6	Owego (T)	special facility	minimal	Owego (T)	Boat launch well integrated with adjacent park facilities.	II
River Road Park No. 2	T-5	Owego (T)	basic park and special facility	minimal	Tioga County	Campsite and park form an impor-tant link in the multi-faceted park system planned for this portion of the river.	I
Campville Park	T-4	Owego (T)	basic park	minimal	Owego (T)	Park facility on right bank reinforces other portions of this important recreation node in the Riverbanks park system.	II

TABLE IV-2 (Cont'd)

Name of Facility	Location Mile-point	Location Com-munity	Open Space Type	Level of Develop-ment	Jurisdictional Responsibility	Special Features	Pri-ority
Riverbend Park	T-2	Owego (T)	basic park	minimal	Owego (T)	Provides view of and access to a spectacular section of the river as well as creating a visual link with the urbanized area of Apalachin.	III
Ingersoll Road Park	0-0	Owego (T)	basic park	minimal	Owego (T)	Provides connecting link for riverbanks park system to open space incorporated in existing subdivision.	II
County Line Park	0-0	Owego (T) Union (T)	intensive use park	full	Two Counties		II
Vestal Park	B-3	Vestal (T)	intensive use park	full	State	Boat launch and campsite fully integrated into this major park which is, in turn, oriented to existing parks on right bank and to strip connections and conservation area.	III
Vestal Gardens Park	B-5	Vestal (T)	intensive use park	full	Broome County		I
Twin Orchards Park	B-5	Vestal (T)	basic park	minimal	Vestal (T)	Provides contrast to proposed park on right bank while maintaining continuity of park system on left bank.	III

TABLE IV-2 (Cont'd)

Name of Facility	Location: Mile-point	Location: Community	Open Space Type	Level of Development	Jurisdictional Responsibility	Special Features	Priority
Route 17 Park	B-6	Union (T)	intensive use park	full	Broome County	Highly developed urban park linked to strip connection, conservation areas and densely concentrated park facilities.	II
Willow Point Park	B-7	Vestal (T)	basic park	minimal	Vestal (T)	Focal point of strip connection and conservation area; rural atmosphere in an urban setting.	III
River Park	B-9	Johnson City (V)	intensive use park	full	Johnson City (V)	Boat launch and park provide continuity for strip connection and counterpoint for Round Top Hill on opposite bank.	II
Old Canal Bed Park	B-9	Vestal (T)	basic park	minimal	Broome County	Provides link between Round Top and strip connection on left bank.	II
Confluence Park	B-12	Binghamton (C)	intensive use park	full	Binghamton (C)		III
Pierce Creek Park	B-14	Binghamton (C)	basic park & special facility	minimal	Binghamton (C)	Boat launch and park provide focal point for strip connection and added interest to left bank.	II

TABLE IV-2 (Cont'd)

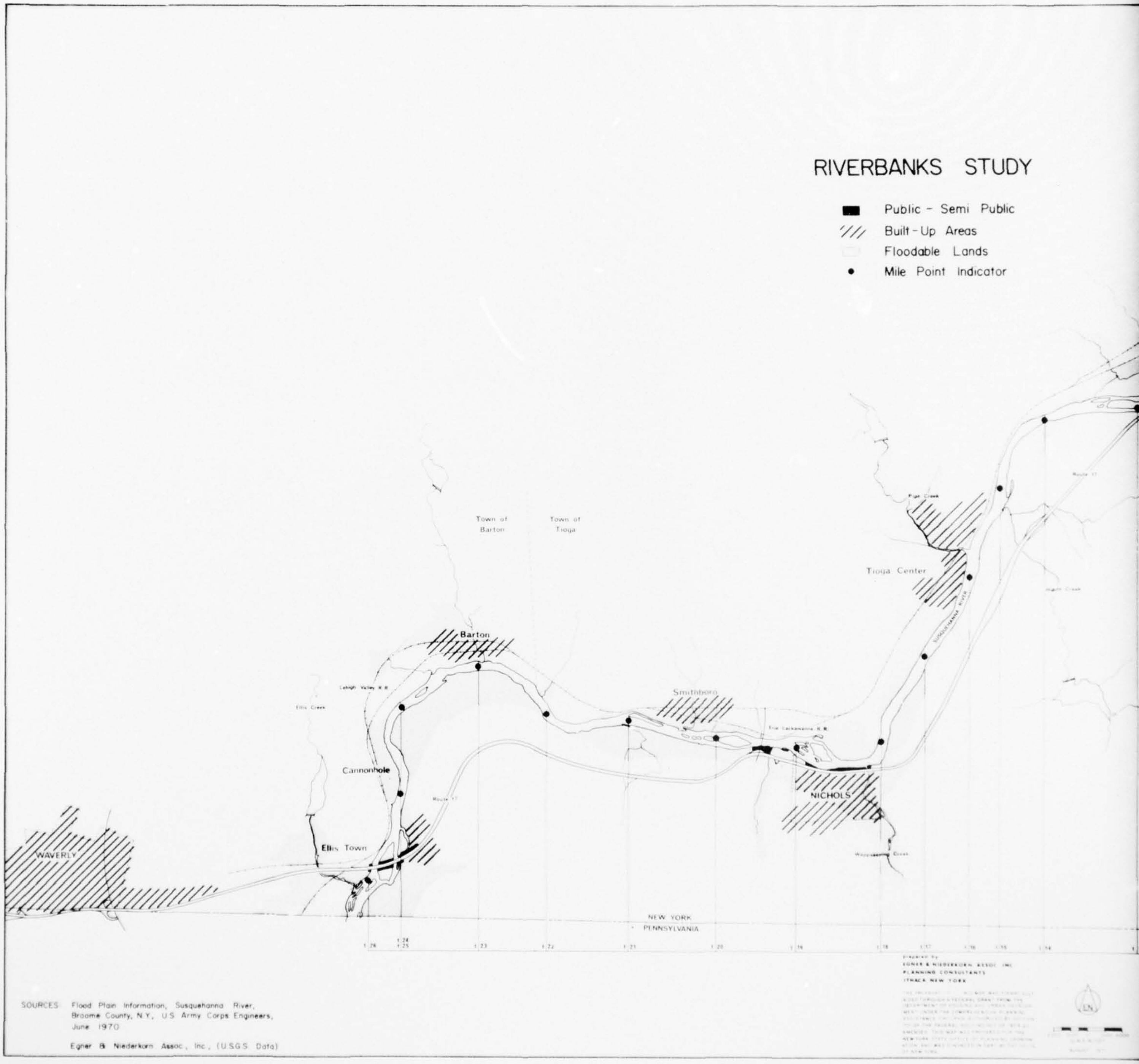
Name of Facility	Location Mile-point	Location Com-munity	Open Space Type	Level of Develop-ment	Jurisdictional Responsibility	Special Features	Pri-ority
Rogers School Park	B-15	Conklin (T)	basic park	minimal	Conklin (T)	Park to become central feature of riverbank restoration program.	III
Acre Creek Park	B-16	Kirkwood (T)	special facility	minimal	Kirkwood (T)	Boat launch.	II
5 Mile Point Park	B-18	Kirkwood (T)	intensive use park	full	Broome County	Creation of a major park and campsite at this point will capitalize on existing facilities and act as terminating element in the urbanized sector of the plan.	II
Conklin Center Park Extension	B-19	Conklin (T)	basic park	minimal	Conklin (T)	Creates the potential for maximum use of existing parks.	II
South Conklin Center Park	B-20	Conklin (T)	special facility	minimal	Conklin (T)	Campsite provides additional diversity in Conklin park system.	III
Kirkwood Park Extension	B-21	Kirkwood (T)	basic park	minimal	Kirkwood (T)	Adds dimension to existing park and potential for additional use.	III

TABLE IV-2 (Cont'd)

Name of Facility	Location		Open Space Type	Level of Development	Jurisdictional Responsibility	Special Features	Priority
	Milepoint	Community					
Conklin Park	B-21	Conklin (T)	special facility	minimal	Conklin (T)	Campsite integrated with conservation area and strip connection.	III
Corbettsville Park	B-23	Conklin (T)	intermediate park	moderate	Broome County	Campsite and park terminate strip connection and conservation area.	I
Riverside Park	B-24	Kirkwood (T)	special facility	minimal	Kirkwood (T)	Boat launch and campsite interwoven with strip connection and conservation area.	II
I-81 Park	C-2	Dickinson (T)	intensive use park	full	State	Large strip park development utilizing excess land purchased for highway purposes.	I
Port Dickinson Park	C-3	Port Dickinson (V)	basic park	minimal	Port Dickinson (V)	Small park accentuates strip connection and complements I-81 park development.	II
Castle Creek Park	C-5	Chenango	basic park & special facility	minimal	Broome County	Campsite and small park accent the magnitude of overall riverbanks plan for this area.	II
River Isle Park	C-9	Chenango (T)	basic park & special facility	minimal	Chenango (T)	Boat launch and park complement strip connection and conservation area.	II

TABLE IV-2 (Cont'd)

Name of Facility	Location: Mile-point	Location: Community	Open Space Type	Level of Development	Jurisdictional Responsibility	Special Features	Priority
Route 396 Park	C-10	Fenton (T)	special facility	minimal	Fenton (T)	Campsite integrated with conservation area and park complex on opposite bank.	II
State Park Extension	C-13	Fenton (T)	intensive use park	full (as necessary to supplement existing facilities)	State	Extension of the park makes access to the confluence of the 3 rivers possible and accentuates this dramatic natural resource.	II


RIVERBANKS STUDY
Public - Semi Public
Built-Up Areas
Floodable Lands
Mile Point Indicator
Town of Barton
Town of Tioga
Barton
Lehigh Valley R.R.
Ellis Creek
Smithboro
Tioga Center
Pipe Creek
Susquehanna River
Erie Lackawanna R.R.
Cannonhole
Route 17
Ellis Town
WAVERLY
NICHOLS
NEW YORK
PENNSYLVANIA
Prepared by
EGNER & NIEDERKORN ASSOC. INC.
PLANNING CONSULTANTS
ITHACA NEW YORK
SOURCES: Flood Plain Information, Susquehanna River, Broome County, N.Y., U.S. Army Corps Engineers, June 1970
Egner & Niederkorn Assoc., Inc., (U.S.G.S. Data)


TUDY
Public
ds
licator
Town of Tioga
Town of Owego
Owego Creek
OWEGO
Little Nanticoke Creek
Hiawatha Island
Route 17
Pumpelly Creek
Town of Nichols
Town of Owego
Route 17
Huntt Creek
Campville
Apalachin
Apalachin Creek
Town of Owego
Town of Union
Nanticoke Creek
Ross Corners
Tracy Creek
TIOGA COUNTY
BROOME COUNTY
Town of Owego
Town of Vestal
NEW YORK
PENNSYLVANIA
BROOME · TIOGA
RIVERBANKS STUDY

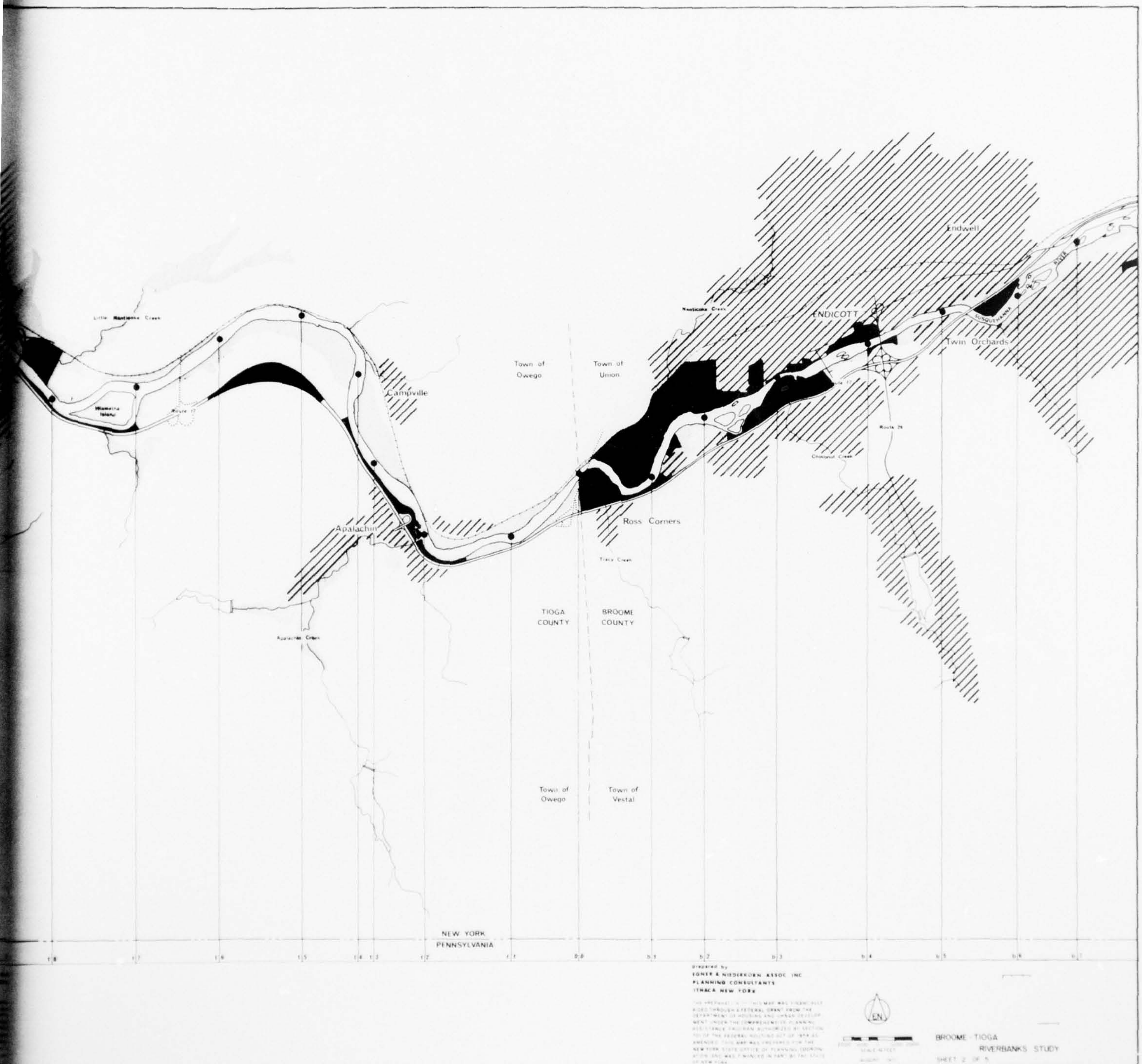

Endwell
ENDICOTT
Twin Orchards
Little Nanticoke Creek
Nanticoke Creek
Campville
Town of
Owego
Town of
Union
Apalachin
Ross Corners
Tracy Creek
Choconut Creek
Route 17
Route 26
TIOGA
COUNTY
BROOME
COUNTY
Apalachin Creek
Town of
Owego
Town of
Vestal
NEW YORK
PENNSYLVANIA
Prepared by
EGNER & NIEDERKORN ASSOC. INC.
PLANNING CONSULTANTS
ITHACA NEW YORK
BROOME - TIOGA
RIVERBANKS STUDY
SHEET 2 OF 5

FIGURE IV-2

BROOME COUNTY
CHENANGO COUNTY
Chenango Forks
Port Crane
JOHNSON CITY
BINGHAMTON
Five Mile Point
RIVERBANKS STUDY
Public – Semi Public
Built - Up Areas
Floodable Lands
Mile Point Indicator

AD-A044 009 CORPS OF ENGINEERS BALTIMORE MD BALTIMORE DISTRICT F/G 13/2
BINGHAMTON WASTEWATER MANAGEMENT STUDY. SPECIALTY APPENDIX.(U)
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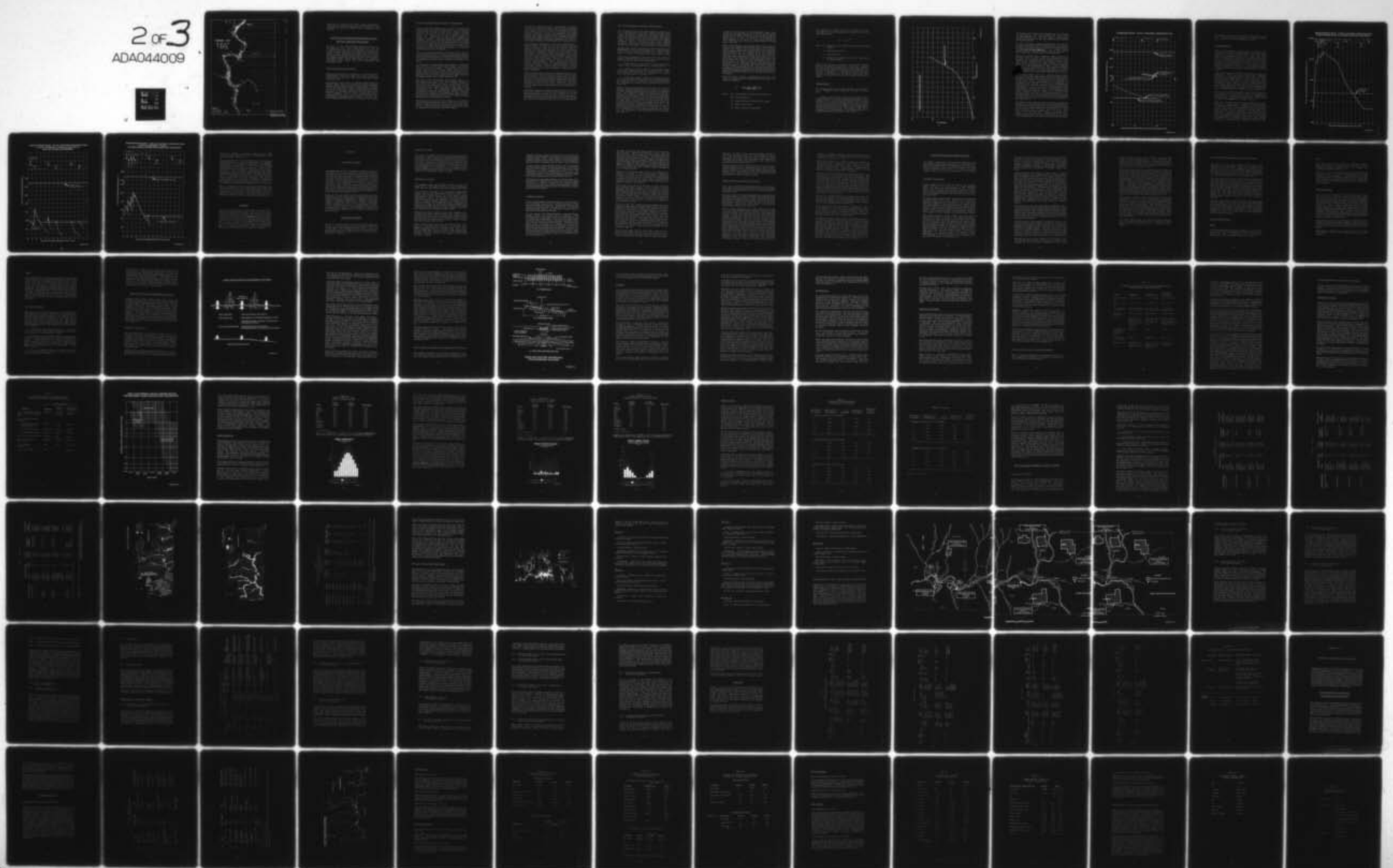


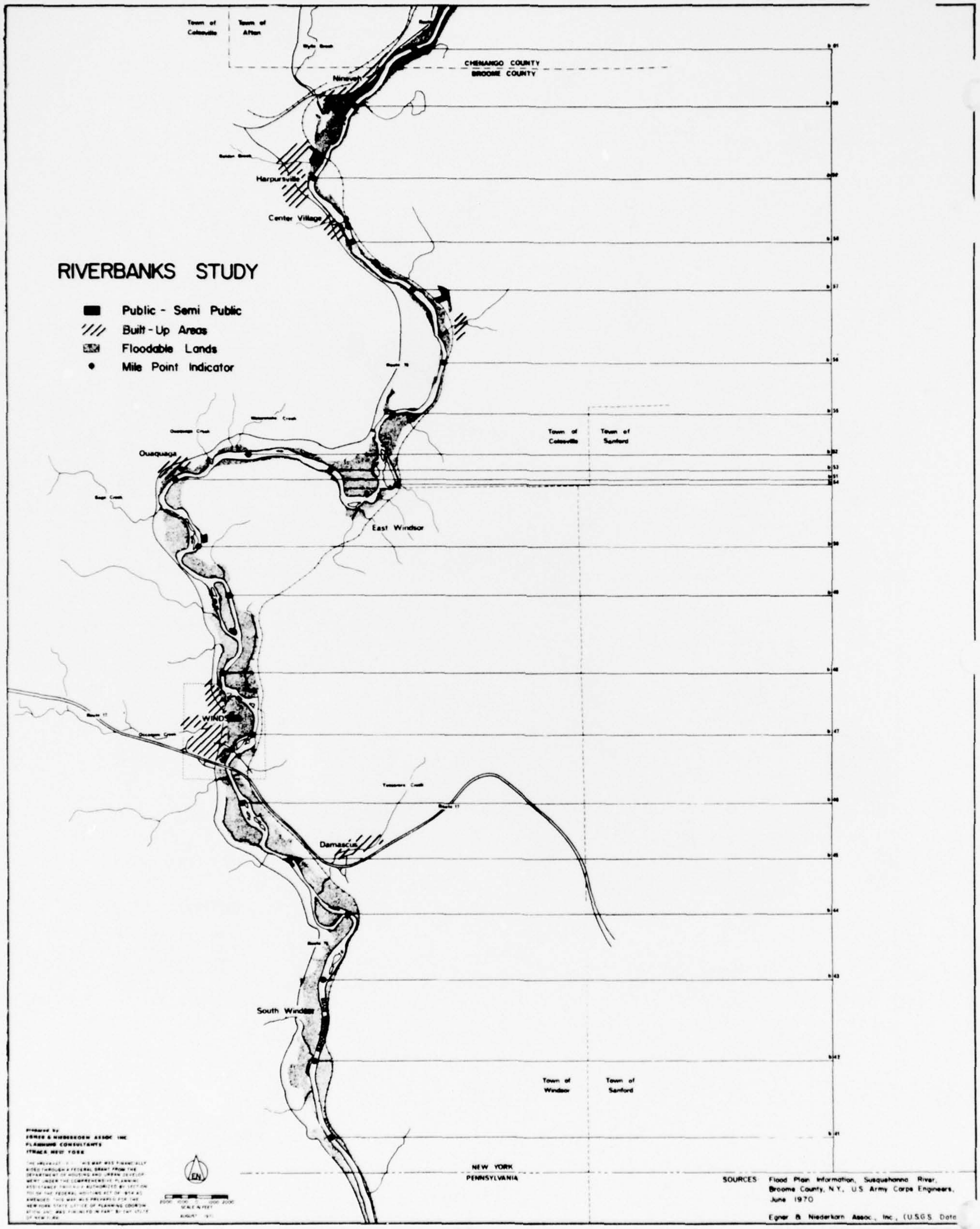


FIGURE IV-2 (CONT)

converted to a marina in the future. Some riverbanks are under private ownership and may be developed for such purposes as private recreational clubs or possibly as golf courses.

IMPACTS OF WASTEWATER MANAGEMENT PLANS ON RIVER-ORIENTED RECREATION

As stated in the Federal Water Pollution Control Act Amendments of 1972, (PL 92-500) Title I, Sec. 101, "It is a national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983." The following paragraphs discuss the impacts of wastewater management plans for the Urban Study Area concerning recreation along, within, and on the Susquehanna and Chenango Rivers.

IMPACTS ON RIVER PARK SITES

During the construction of wastewater collection and treatment facilities, some river park sites may be temporarily disturbed by such factors as dust, noise, and heavy equipment movement.

Construction of interceptors or effluent outfall through the Route 81 River Park may temporarily disturb picnicking, walking, and bicycling activities within the park. Construction of a Chenango Valley sewage treatment facility, slightly to the west of the park, should not disturb the park itself. Operation of a Chenango Valley STP may affect the recreational atmosphere of the park if objectionable odors, emanating from the STP, are carried to the park site. Installation of mitigating measures such as covers for activated sludge tanks could prevent the spread of such odors.

IMPACTS ON SECONDARY CONTACT RECREATION

Factors which may influence the success of boating and canoeing activities on the Susquehanna River and Chenango River include: amount of river flow, stream currents, obstacles in the river, boat launch facilities, floating debris, and location and density of aquatic vegetation. During the construction of wastewater collection and transport systems, especially during the construction of pipelines across rivers, the amount and enjoyment of boating and canoeing activities may be lessened due to diversions of river flow and temporary installation of obstacles within the river. Boating and canoeing activities would not be significantly affected during the operation of wastewater collection and treatment facilities.

Those wastewater management alternatives which would incorporate processes for removal of nitrogen and phosphorus prior to effluent discharge may help to eliminate the nuisance macrophytes within the river system and may thus increase the potentials for enjoyment of boating and canoeing activities.

No wastewater management plan would improve accessibility to the river (e.g., boat launch sites, parking, etc.) for prospective boaters and canoers. Major factors affecting the amount and enjoyment of sport fishing within the river system include access to the river and water quality (especially in terms of dissolved oxygen and ammonia), and other physical/ chemical water characteristics which affect the propagation and activity of sport fishing species.

The waters of the Susquehanna and Chenango Rivers are presently used for warm water sport fishing. Stocking of warm water fish species, such as smallmouth bass and walleye, has not taken place within the two main streams since 1969; thus it would seem that existing water quality is conducive for the propagation, maintenance, and migration of these warm water species. During construction of wastewater collection and transport systems, especially during river crossings, increased turbidity within the river may lessen the enjoyment and success of fishing activities downstream of the construction activity.

The physical and chemical characteristics of wastewater effluent discharged into the rivers, which affect the propagation, growth, and activity of sport fish, may in turn affect the success and enjoyment of warmwater sport fishing during the operation of wastewater treatment facilities.

Temporary dissolved oxygen concentrations of between 3 and 4 mg/l within the rivers would not halt the propagation of sport fish. It may restrict their growth and development and thus limit the success and enjoyment of sport fishing. Dissolved oxygen concentrations consistently greater than 5 mg/l would ensure the continued propagation, growth, and healthy activity of river sport fish, thus contributing to the enhancement and continued success of warm-water sport fishing in the Susquehanna and Chenango Rivers.

Other chemical constituents of wastewater effluent such as ammonia (NH3) and chlorine may also affect warmwater fishery resources. High concentrations (greater than 2.0 mg/l) of un-ionized ammonia may be toxic to warmwater fish species, especially in alkaline waters (pH greater than 8.0). Those wastewater management plans which would consistently ensure an ammonia concentration of less than 2.0 mg/l would contribute to the continued enjoyment and success of warm-water sport fishing. Free chlorine and chloramines have been found to be toxic to aquatic life at various concentrations. Those wastewater treatment schemes utilizing chlorine as a disinfectant may adversely affect future fishery resources unless provisions to ensure a low total instream residual chlorine contact chamber and/or amperometric feed of chlorine are provided at the treatment plants.

Finally, physical and chemical water quality parameters may have synergistic effects on fishery resources. For example, two parameters, such as dissolved oxygen and ammonia, which are at or near levels which are detrimental to aquatic life may create greater distress to aquatic life than either constituent alone. Thus, those wastewater treatment schemes which ensure safe levels, for all constituents of concern, will be the most beneficial for future sport fishing activities.

Wastewater management plans cannot by themselves benefit other factors which can contribute to additional success and enjoyment of fishery resources, such as adequate access and parking facilities for fishermen. Thus, wastewater management plans may improve the potential for future sport fishing but may not in actuality increase the level of participation.

IMPACTS ON PRIMARY CONTACT RECREATION

The "Proposed Criteria for Water Quality" issued by the U. S. Environmental Protection Agency (October 1973), suggest a number of parameters, including temperature, clarity, pH, and fecal coliform concentration, which should be used for determining if waters are suitable for primary contact recreation. The New York State Water Quality Standards, however, differentiate those waters suitable for primary water contact and secondary contact solely on the basis of total coliform and fecal coliform concentrations.

Existing water quality classifications on the Susquehanna and Chenango Rivers were shown on Figure IV-1. Waters classified as "B" are suitable for primary water contact, while Class "C" waters are suitable only for secondary contact.

A wastewater management plan may affect total and fecal coliform concentrations and in turn affect stream classification in one or more of the following ways:

a. A plan may result in coliform concentrations which conform to the existing standard for a particular class.

b. A plan may result in coliform concentrations which contravene existing standards for a particular class. Thus, the existing water class may be redesignated to a lower class, say from Class "B" to Class "C".

c. A plan may result in coliform concentrations which represent substantial improvements over existing standards for a particular class. Thus the existing water class may be redesignated to a higher class, say from Class "C" to Class "B".

Analyses of in-stream coliform concentrations for both the Chenango and Susquehanna Rivers was made for a range of possible conditions depending on the wastewater management plan. The minimum-average-seven-consecutive-day flow occurring once in ten years (MA-7-CD10 flow) of the Susquehanna River was found to be 300 cubic feet per second (cfs). For the purposes of this Study, the MA-7-CD10 flow of the Chenango River was assumed to be about 135 cfs (based on a rough estimate of the flow and drainage proportions to the Susquehanna River). During the design storm (i.e., the intensity of a rainfall of 1.25 inches/day for which the stormwater treatment mechanisms were designed), the flow in the Susquehanna River was assumed to be 600 cfs and the flow, by proportion, in the Chenango River was assumed to be 200 cfs.

Velocities (travel time) in the Susquehanna River were assumed to be approximately 0.13 feet per second during the MA-7-CD10 flow, and 0.28 feet per second during the design strom river flow. Velocities in the Chenango River were assumed to be 0.34 feet per second during the MA-7-CD10 flow and 1.0 feet per second during the design storm river flow.

Both the Susquehanna and Chenango Rivers were found to reflect a total coliform count at some fairly consistent background level. Median summer total coliform concentrations in the Chenango River were approximately 120 organisms/100 ml and this value was assumed to be the background coliform level for the Chenango River under both the MA-7-CD10 flow conditions and under the design storm flow conditions. The median summer total coliform concentration in the Class "A" waters of th e Susquehanna River was approximately 210 organisms/100 ml, and this value was assumed to be the background coliform concentration in the Susquehanna River during the MA-7-CD10 flow conditions. A value of 460 organisms/100 ml was assumed to be the background coliform concentration in the Susquehanna River during design storm conditions to account for increased non-point source pollution such as sewer overflows during storm conditions.

Initial in-stream coliform concentrations from any point source of coliform can be determined by mass balance calculations as follows:

$$Ci = \frac{(CA \times FA) + (CS \times FS)}{(FA + FS)}$$

Where: CA = Concentration of coliform from Source A

FA = Flow of Source A

CS = Concentration of coliform in the stream

FS = Flow of the stream

Ci = Initial coliform concentration

Concentrations of coliform at any time downstream of coliform inputs can be subsequently determined by use of the following equation:

$$Ct = Ci\ 10^{-kt}$$

Where: Ci = Initial instream coliform concentration at coliform source.

k = Bacteria die-off rate

t = time (in days)

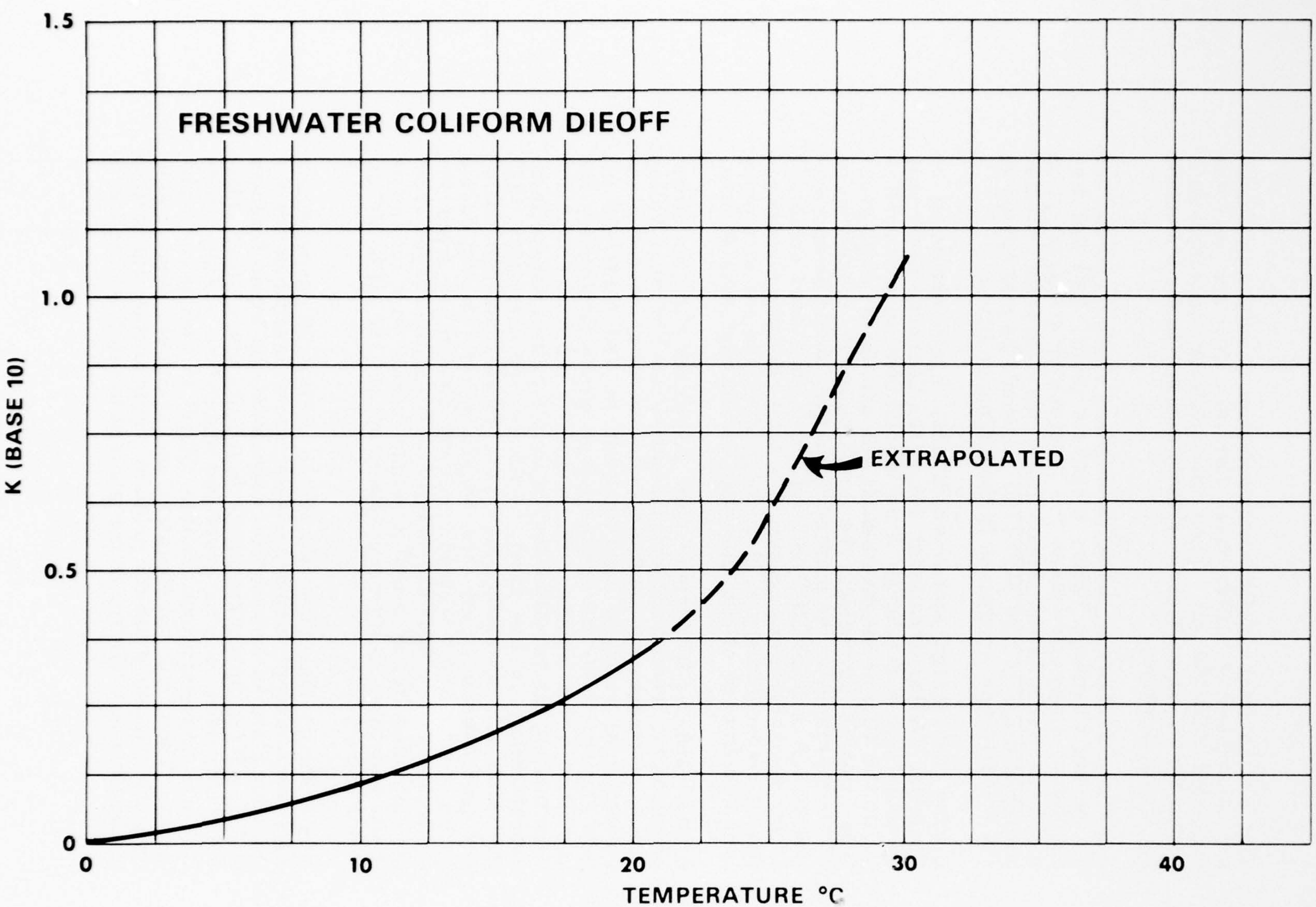
Ct = coliform concentration at any time t downstream of coliform inputs.

Bacterial die-off rate, k, (in days -1) varies as a function of such environmental conditions as temperature, salinity, pH. The graph shown in Figure IV-3 plots various observed k values (to the base 10) as reported in the literature as a function of temperature. Assuming a summer river temperature of 26 degrees C, the die-off rate for the Chenango and Susquehanna Rivers would be approximately 0.65 days-1.

Chenango River

The Chenango River is currently classified as a Class B water. NYSDEC coliform standards for Class B waters are:

"Monthly median coliform value for one hundred ml of sample shall not exceed two thousand four hundred from a minimum of five examinations and provided that not more than twenty per cent of the samples shall exceed a coliform value of five thousand for one hundred ml of sample and the monthly geometric mean fecal coliform value for one hundred ml of sample shall not exceed two hundred (200) from a minimum of five examinations. This standard shall be met during all periods when disinfection is practiced."



FRESHWATER COLIFORM DIEOFF
EXTRAPOLATED
K (BASE 10)
1.5
1.0
0.5
0
0
10
20
30
40
TEMPERATURE °C

FIGURE IV-3

The median total coliform concentration observed in August and September of 1974 was 120/100 ml, and no value exceeded 5000/100 ml. Thus the coliform concentrations within the Chenango River currently conform to the standards for Class B waters.

For those wastewater management plans which do not include a separate Chenango Valley treatment plant, (see full discussion of alternative plans for Wastewater management in the <u>Plan Formulation Appendix</u>), the present median coliform value of 120 MPN/100 ml would be maintained at MA-7-CD10 flow conditions in the Chenango River.

During the design storm conditions, again assuming no Chenango Valley treatment plant, the Chenango River will be subject to a discharge from a combined sewer overflow within the City of Binghamton. If this combined sewer overflow remains untreated, the total coliform concentration within the river, at the point of discharge, would be approximately 3.5 x 10(5) MPN/100 ml. This untreated combined sewer discharge would result in a total coliform concentration of approximately 1.23 x 10(5) MPN/100 ml just prior to the confluence of the Chenango and Susquehanna Rivers.

At the MA-7-CD10 river flow conditions with no storm condition the treated effluent discharge of a Chenango Valley secondary treatment plant would result in a maximum instream total coliform concentration of 180 MPN/100 ml (see Figure IV-4). If, during design storm conditions, the combined sewer overflow is treated by microstraining and chlorination, the resultant maximum instream total coliform concentration in the river would be approximately 1125 MPN/100 ml, assuming that there is no Chenango Valley sewage treatment plant (see Figure IV-4). During design storm conditions, treated effluent discharges from the Chenango Valley STP and treated effluent discharges from the combined sewer overflow would result in a maximum in-stream total coliform concentration of 1150 MPN/100 ml (see Figure IV-4).

It is apparent that under all future wastewater management conditions, except during the design storm conditions for the Baseline Plan, in-stream total concentrations would conform to Class B swimming standards in the Chenango River. Only when untreated storm overflows enter the river, would coliform concentrations violate Class B swimming standards. Thus all wastewater management plans would improve the potentials for primary water contact recreation in the Chenango River, in comparison to the Baseline Plan.

CHENANGO RIVER: TOTAL COLIFORM CONCENTRATION

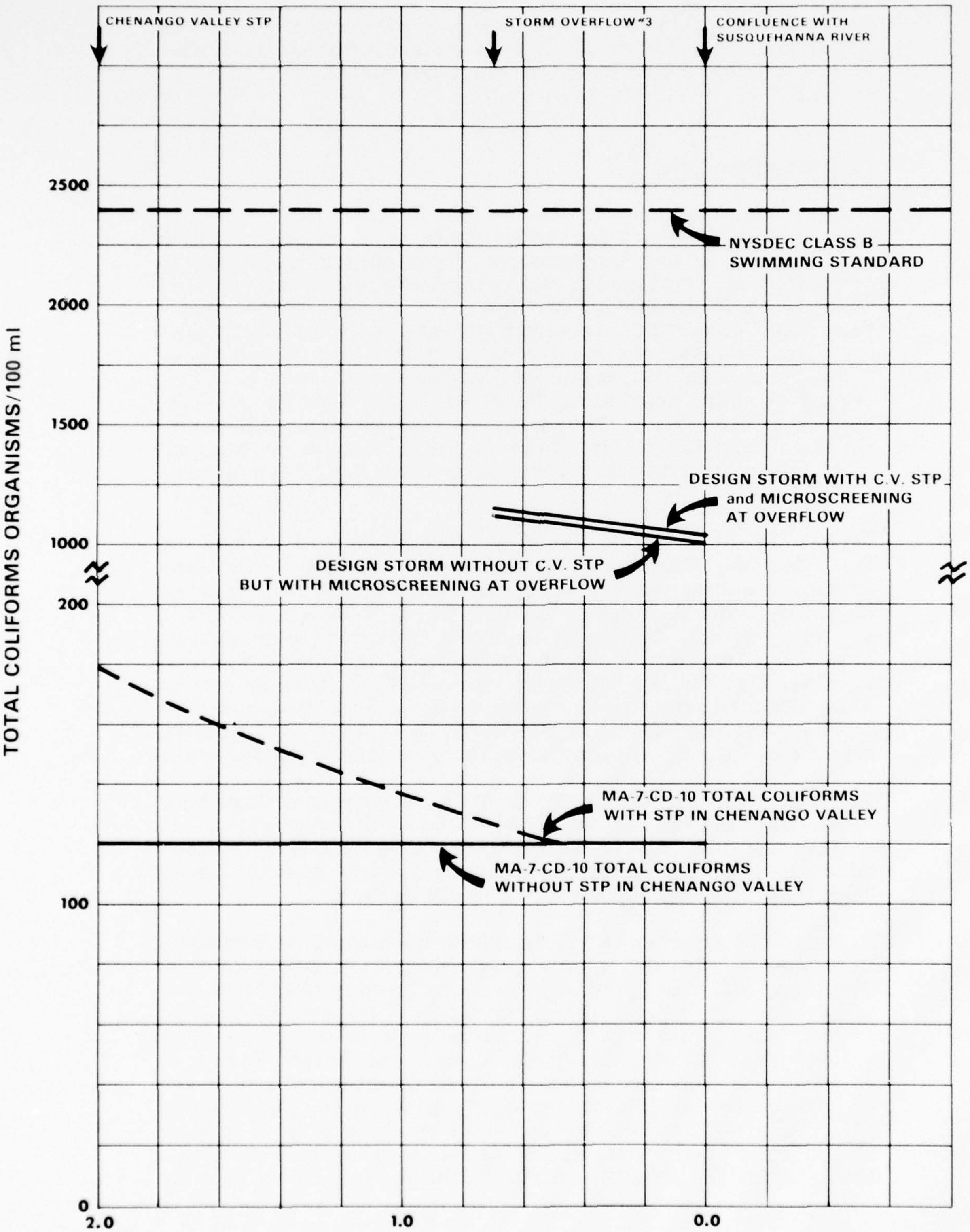


FIGURE IV-4

It is unlikely, however, that any plan will help improve the other conditions which limit primary recreational activities (e.g., access, river flow, parking, currents).

Susquehanna River

Figure IV-5 presents the concentrations of coliform which would result in the Susquehanna River during design storm conditions if combined sewer overflows were not treated prior to their discharge into the river. Under these conditions, and assuming secondary treated effluent discharges from six sewage treatment plants, both Class B and Class C coliform standards would be violated for at least a 6 hour period at every point along the river from the City of Binghamton to almost the Owego No. 2 sewage treatment plant. Coliform standards for Class B waters would be violated to approximately half way between the Owego STP's numbers 1 and 2.

Figure IV-6 presents coliform concentrations within the Susquehanna River during MA-7-CD10 flow conditions assuming six secondary treated sewage effluent discharges (3 Broome and 3 Tioga) with no storm occurrence. There are no in-stream total coliform concentrations high enough to prohibit primary contact recreation. Regionalization of the Chenango Valley effluent to the B-JC STP would result in somewhat higher peak total coliform concentrations than does subregionalization, although neither regionalization scheme results in violation of coliform swimming standards.

Total river flow at the Owego STP #1 and Owego Village STP is so large, even at the MA-7-CD10, in comparison to treated effluent discharges, that coliform concentrations within the river remain at background levels whether these two plants are regionalized or remain separate.

Figure IV-7 presents total in-stream coliform concentrations under design storm conditions assuming microscreening and chlorination of combined sewer overflows and six secondary sewage treatment plants. It should be pointed out that combined sewer overflows represent "plug" flow within the river system. Therefore, the graph shown in Figure IV-7 represents those coliform concentrations in the river which would be observed if one were to travel along with the plug flow. At any point along the river, the influence of combined sewer overflows would occur within a 6 hour period (i.e. the length of time of overflow occurrence) after

SUSQUEHANNA RIVER: TOTAL COLIFORM CONCENTRATION DESIGN STORM WITH NO STORM OVERFLOW TREATMENT

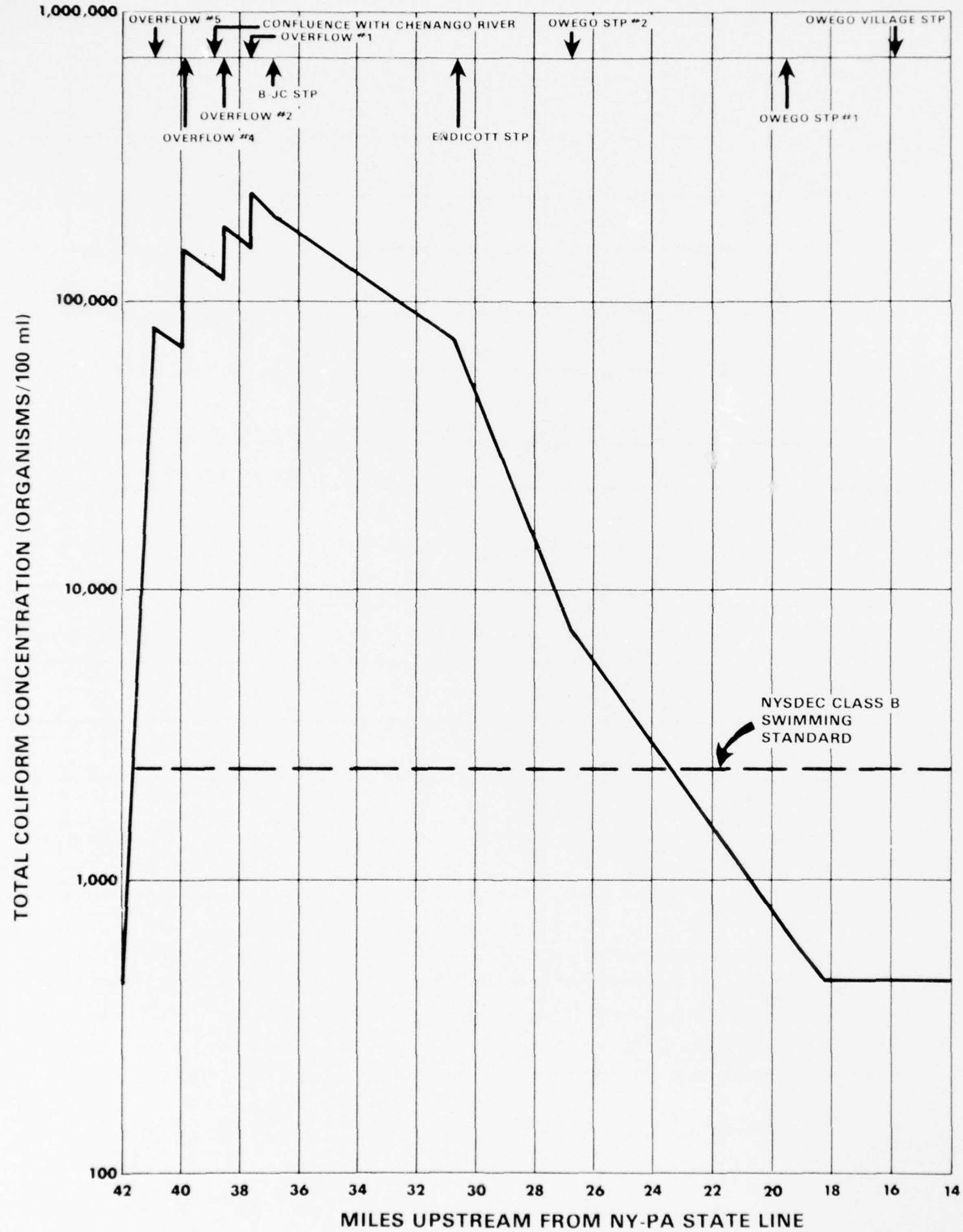


FIGURE IV-5

SUSQUEHANNA RIVER: TOTAL COLIFORM CONCENTRATION 6 STP'S (3 BROOME, 3 TIOGA) at MA-7-CD-10 WITH NO STORM OCCURRENCE

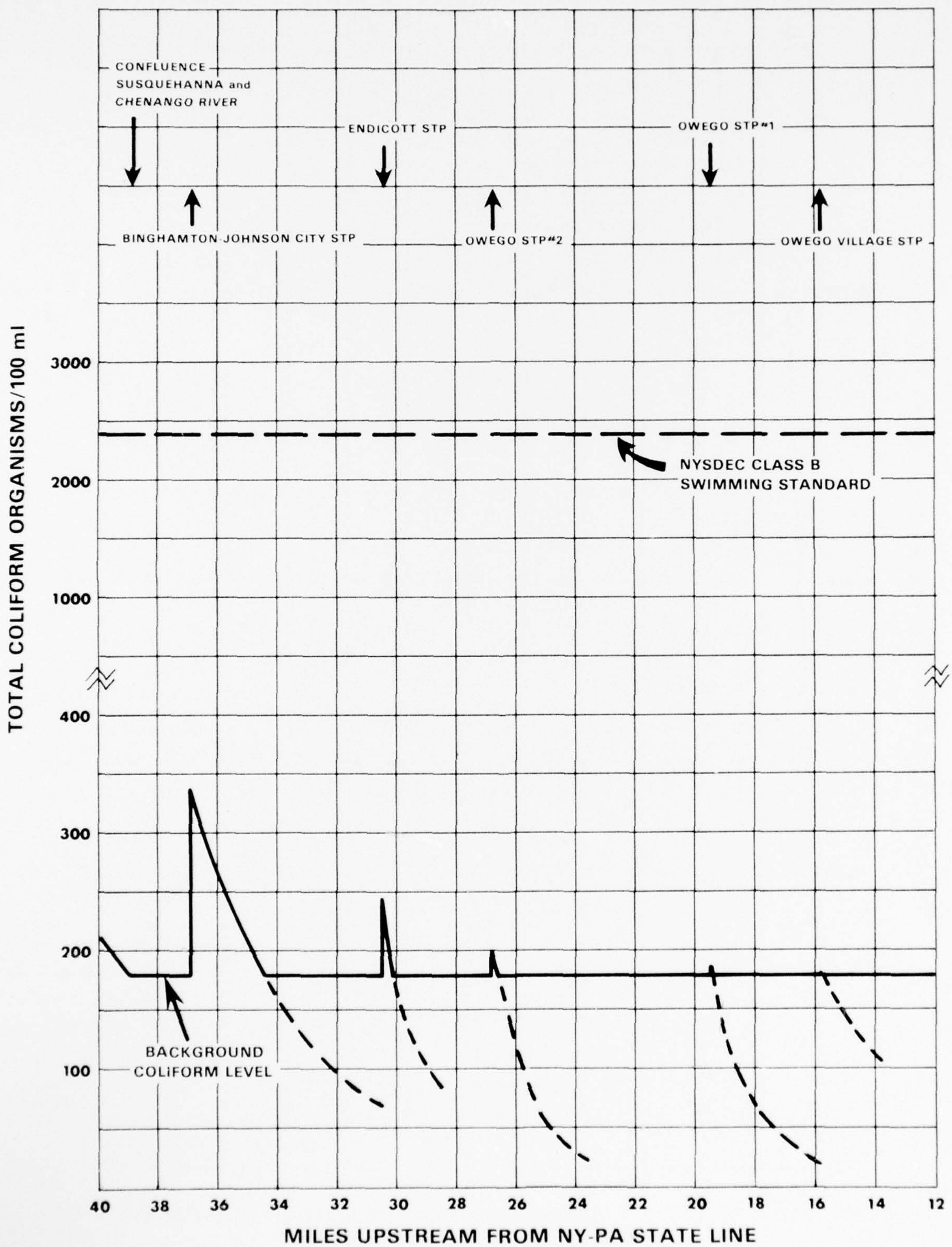
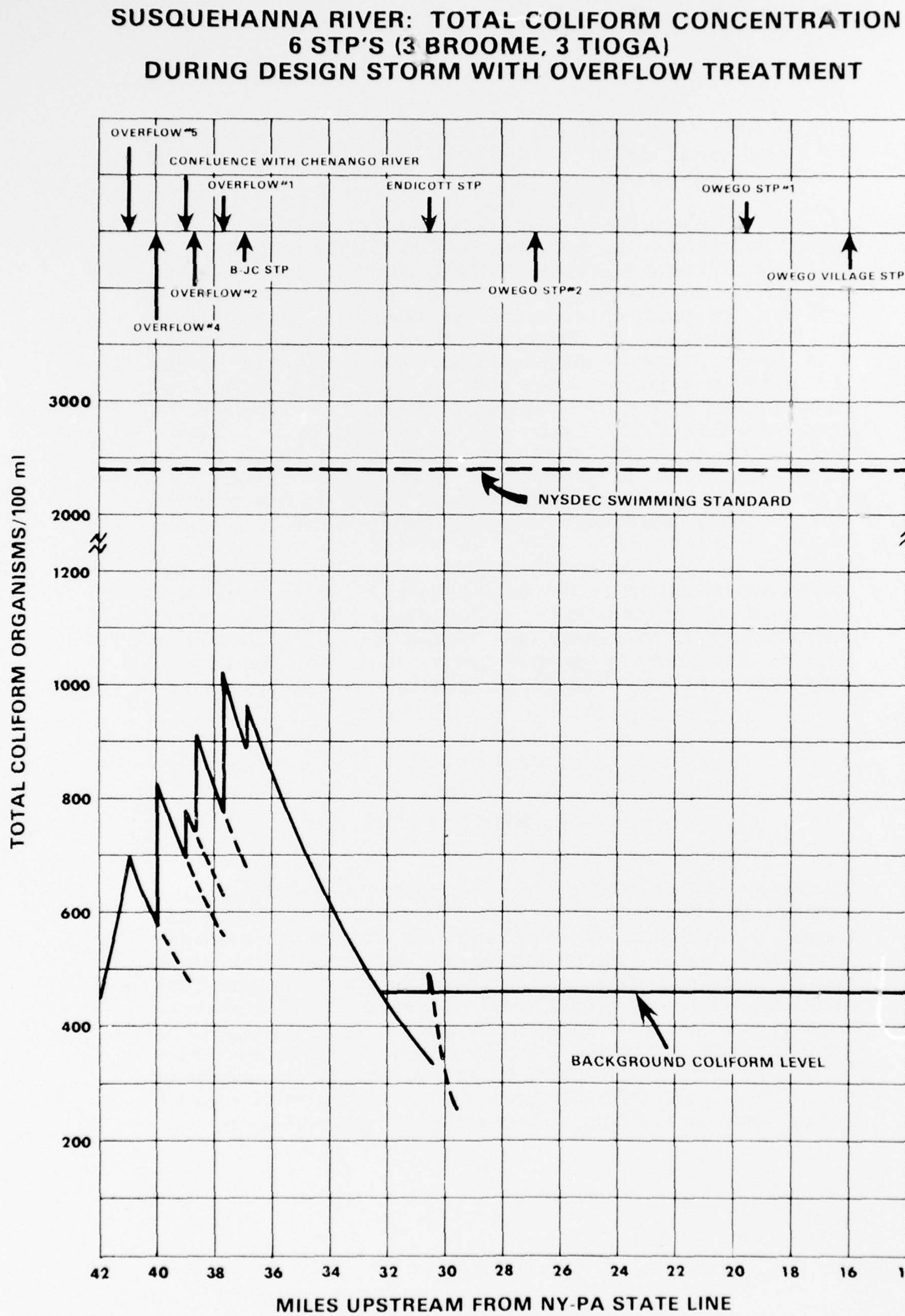


FIGURE IV-6



SUSQUEHANNA RIVER: TOTAL COLIFORM CONCENTRATION
6 STP'S (3 BROOME, 3 TIOGA)
DURING DESIGN STORM WITH OVERFLOW TREATMENT
OVERFLOW #5
CONFLUENCE WITH CHENANGO RIVER
OVERFLOW #1
ENDICOTT STP
OWEGO STP #1
B-JC STP
OVERFLOW #2
OVERFLOW #4
OWEGO STP #2
OWEGO VILLAGE STP
NYSDEC SWIMMING STANDARD
BACKGROUND COLIFORM LEVEL
TOTAL COLIFORM ORGANISMS/100 ml
3000
2000
1200
1000
800
600
400
200
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
MILES UPSTREAM FROM NY-PA STATE LINE

FIGURE IV-7

which only continuous discharges within the river (STP effluents) would influence coliform concentrations at any particular point on the river.

As seen in Figure IV-7, even treated storm sewer overflows significantly increase coliform concentrations in relation to background river coliform concentrations. Nevertheless, total coliform concentrations do not exceed the NYSDEC standard for primary contact recreation. Separate treatment facilities for the Chenango Valley area result in somewhat lower total coliform concentrations than under conditions of regionalization with the B-JC STP. Beyond the Endicott STP discharge, total coliform concentrations in the river are essentially equivalent to normal total coliform concentrations upstream of any discharges. The influence of the Owego No. 1, Owego No. 2, and Owego Village STP discharges on coliform concentrations are so minor as to be essentially unmeasurable during design storm conditions.

Again, it is apparent that the major factors influencing coliform concentrations in the Susquehanna River are untreated combined sewer overflows. For those plans which treat combined sewer overflows, the Susquehanna River should be suitable for primary contact recreation from the City of Binghamton to Owego Village, at least up to the design storm.

SUMMARY

The major factor affecting river-oriented recreation from a wastewater management viewpoint is the occurrence of untreated combined sewer overflows. All wastewater management plans would improve the potential for primary water contact recreational activities in the Susquehanna and Chenango Rivers as compared to the Baseline Plan. However, aspects such as river access, adequate bathing supervision, slow or swift currents, a rocky bottom, or various other factors would not be affected by any wastewater management plan. Thus, potentials for primary contact recreation in the Susquehanna or Chenango Rivers may not be realized.

CHAPTER V

LAND APPLICATION

Land application of both wastewater and sludge was given a substantial role in the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500) to assist implementing the "national goal that discharge of pollutants into navigable waters be eliminated by 1985." Several sections of the law encourage that land application be considered as a viable alternative to conventional disposal practices for wastewater and sludge. The application of municipal sludges and effluents to land is a desirable practice both from the standpoint of recycling and reuse of plant nutrients and water, and from the need of municipalities for waste disposal sites. With proper management and monitoring, land disposal can be an effective and desirable practice.

During recent years, there has been a tremendous increase in interest for land application of municipal wastewater and sludge throughout the United States. Objectives and philosophies regarding applications of municipal sludge and effluents on land vary with location, climate, topography, geology, groundwater levels, soil characteristics, wastewater or sludge characteristics, and individual evaluations of environmental impacts. This chapter investigates the potential for land application as it relates to Broome and Tioga Counties.

SOIL-PLANT SYSTEM

The basic treatment medium for any type of land application scheme is the soil-plant system, sometimes called the "living filter." When nutrients and/or water are added to the soil-plant system in either liquid or slurry forms, the interactions within the living filter may be either physical, biological or chemical.

PHYSICAL FILTER

The long-term capability of the soil to act as a physical filter is closely related to chemical and biological interactions after treated sewage effluent is applied to the soil. The key to maximum use of the soil filter is water management and movement. Clogging or standing water will deter the filter and cause runoff. The area will then become anaerobic with accompanying odor, gas production, and unsanitary conditions. Clogging can be controlled by cyclic applications of treated sewage up to soil capacity (a sandy soil can transmit effluent more rapidly than a fine clay soil).

BIOLOGICAL FILTER

As a biological filter, soil contains microbes, animals, and higher plants. Bacterial numbers run into the billions per cubic inch, but that number decreases rapidly with depth.

Soil microbes decompose and metabolize biodegradable organic materials to carbon dioxide and water. The decomposition rate depends upon the soil; the majority of sludge decomposition occurs within the first month following application. Microbes also degrade or detoxify potentially toxic or unwanted organic compounds; for example, pesticides or phenols. Microorganisms modify absorption and mobility of cations and anions (including phosphorus and heavy metals) within the soil profile, modify the adsorption of nutrient elements and heavy metals by plants, and transform nitrogen from immobile to mobile forms.

In Broome and Tioga Counties, the present vegetation cover includes both forests and grasslands. The organic matter is generally higher in soils currently under grasslands than under forests. The nature of the grassland organic residues and their mode of decomposition encourage a higher organic level than is found under forests.

Poorly drained soils, because of their high moisture relations and relatively poor aeration, are generally much higher in organic matter and nitrogen than their better drained equivalents. This is why soils lying along streams are often quite high in organic matter. The decomposition and loss of organic matter in cool regions is lower than in warmer regions.

Attention has been called several times to the close relationship existing between the organic matter and nitrogen content of soils. Since carbon makes up a large and rather definite proportion of this organic matter, it is not surprising that the carbon to nitrogen ratio of soils is fairly constant.

A value for the carbon-nitrogen ratio of 20:1 is commonly used for average soils. The carbon-nitrogen (C/N) ratio in humid, cooler temperature region soils, especially if under cultivation, is lower, ranging from 10:1 to 15:1. The importance of this fact in controlling the available nitrogen, total organic matter, and the rate of organic decay is recognized in developing sound soil management schemes.

Cultivation, by hastening oxidation, should encourage nitrification while a vigorous sod crop such as bluegrass should discourage it. This is because the root and top residues maintain a wide C/N ratio, and the small quantities of nitrate and ammonia nitrogen which appear are immediately appropriated by the sod itself.

CHEMICAL FILTER

To fully understand the soil-plant system, it is also important to recognize some of the chemical properties of soils associated with plant nutrition. Almost all soils have the property of cation exchange. All soil colloids, clay minerals and soil organic matter, are negatively charged and are dominantly solid polyvalent anions.

In a soil system, all essential nutrients, except the nitrate, sulfate, borate, and chloride ions are immobile. This immobility may be attributed to ion adsorption/exchange and to precipitation mechanisms. The root of the plant, then, must grow toward the immobile nutrients and absorb them from coloids contacted by the root hairs. Nutrient immobility, in part, determines the effectiveness of rates and placement practices when soils are fertilized. Thus immobile nutrients like phosphorus, potassium or zinc which are placed or broadcast on the surface of soil as fertilizer after a cultivated crop is established will have essentially no effect on the crop as the treatment is placed and remains outside the root feeding zone.

A mobile nutrient like the nitrate anion moves in and with the soil water. Water can and does move faster in the soil than roots grow and virtually all of the nitrates within the root zone are available to the plant. As long as there are nitrates and water in the root feeding zone, the plant grows normally with respect to nitrates. When the supply in the soil is exhausted, nitrogen deficiency symtoms for the crop appear suddenly and dramatically. In contrast phosphorus deficiency symptoms will remain with the plant from the time it is a few inches tall until maturity because phosphorus is an immobile nutrient.

Salts, and soil solutions high in salts, may inhibit the absorption by plants of ions like calcium, magnesium, potassium, and many of the essential heavy metals as well as create an osmotic pressure outside the root retarding the movement of water into the roots. Salts, especially those associated with wastes, are high in mobile anions such as nitrates, chlorides, and sulfates.

Plant species vary widely in tolerance to toxic metals; in fact, varieties within a species can vary three to tenfold. Vegetable crops very sensitive to toxic metals are the beet family (chard, spinach, red beet, and sugarbeet), turnip, kale, mustard, and tomatoes. Beans, cabbage, and collards, and other vegetables are less sensitive. Many general farm crops (corn, small grains, and soybeans) are moderately tolerant. Most grasses (fescue, lovegrass, Bermudagrass, orchard grass, and perennial rye grass) are tolerant of high amounts of metals.

The use of land with considerable permeability and some cation exchange capacity presents problems that need careful evaluation. The system requires soils with two basic properties, permeability and adsorption capacity, to remove ions from the water, but these tend to counteract each other. In the field, the surface sand will absorb the toxic compounds from the water and replace them with whatever ions are attached to the subsoil sand at the point where the water leaves the filter system. The higher the exchange capacity of the sand, the greater its purification ability. But increasing exchange capacity means increased clay content and decreased water permeability. Therefore, one aspect of site selection is the balance between soil permeability and ion adsorption capacity.

In Broome and Tioga Counties, soils differ widely from region to region. Differences in soil characteristics such as clay type and amount, pH and carbonates, and soil organic matter can influence the stability of the available plant forms

and hence the nature of the chemical reagent required to extract the element from the soil. Thus manganese, aluminum, iron, and most of the heavy metal cations as well as phosphate, molybdenate, and many of the toxic anion forms are examples of ions whose stability varies greatly with changes in pH and organic matter.

Monitoring of groundwater and soil would be required to prevent the buildup of toxic compounds in the soil to levels at which drainage waters become contaminated and permanent damage is done to the quality of food or feed and fiber crops. This becomes a special hazard when the land is used for disposal rather than recycling of wastes.

USE OF SOILS FOR CROPS AND PASTURE

Corn, oats, and mixed hay for feeding dairy cows are important crops on most farms in the Broome and Tioga Counties, and rotation and fertilization practices are concerned mainly with these crops.

Hay has always been the most important farm crop in Broome and Tioga Counties. Alfalfa, another important hay crop, is grown almost entirely on the deep, well-drained soils in the valleys. Small acreages of millet, vetch, sweetclover, Sudan grass, soybeans, and small grains cut for hay make up the minor forage crops. Small areas of wild grass are harvested for forage by a few farmers.

Corn is another important crop. Since 1929, the acreage of corn for grain has increased moderately, and the acreage of corn for silage has increased markedly. The production of silage corn has been encouraged by the increase in dairy farming. Long-term yields of corn for grain show only moderate fluctuations, but there has been a rather sharp rise in yield recently. The use of better varieties and hybrids having more favorable growing seasons have probably contributed to the increase in grain yield. Corn generally follows hay in the crop rotations and normally receives fairly heavy application of barnyard manure. The grain corn is grown mainly on the valleys soils, as the Howard, Chenango, Tioga, and Middlebury, but silage corn is grown on all soils of the county on dairy farms. Wheat is a less important crop than in earlier days, but the yield has increased. Planting of better varieties, limiting the crop to the more productive soils, and better fertilization have contributed to the higher yields. Most of the crop is now grown in the

valleys on Chenango, Howard, and associated soils. Top dressing of manure is commonly applied, and where legume seedings are grown, lime is used.

Minor field crops are rye, barley, mixed grain, and beans. Rye was formerly an important crop and in some years occupied nearly as large an acreage as wheat, but it has declined in importance in recent years. Barley has never been an important crop. Mixed grains, chiefly oats and barley, are grown and ground for dairy feed.

Potatoes were an important crop in the latter part of the past century, but the acreage has declined steadily. The few large commercial producers use the well drained Lordstown and Bath soils of the uplands and the Unadilla and Chenango soils in the valleys. The small growers operate mainly on the well drained uplands, but potatoes for home use are produced in all parts of the counties, even on the poorly drained soils. Commercial potato growers have complete mechanical equipment and use large quantities of commercial fertilizer, but the smaller growers plant potatoes as the row crop in the dairy-farm rotation. Most of the crop is marketed in nearby cities.

Commercial vegetable production is important on only a few farms in the valleys, but many vegetables for home use are grown in gardens or on farms in all parts of the counties. Sweet corn, cabbage, tomatoes, snap beans, and green peas are the main vegetables harvested for sale.

Fruits and berries are widely grown but largely for home use. Apples were important in the late nineteenth century, but the number of trees has declined steadily. Only a few small commercial apple orchards now remain. The production of apples and other tree fruits has declined because the counties do not have a favorable climate.

Fertilization of sod crops generally is not sufficient to meet the crop needs. Higher yields of crops can be expected under improved management. This management consists of using suitable crop rotations; applying lime and fertilizer in kinds and amounts indicated by soil tests; providing adequate drainage and irrigation, where needed; using contour farming, stripcropping, sodded waterways, or other measures to conserve soil and water; controlling weeds and insects; and tilling at the right time and in the right way. Yields are now increasing at the rate of about two percent each year and can be expected to increase further as new varieties of crops are developed, and management is improved.

LAND APPLICATION OF SEWAGE SLUDGE

For decades, many small cities and towns around the world have spread sludge on agricultural lands with beneficial results. In the United States, land application of sewage sludge has been gaining increasing favor and attention. It not only solves a disposal problem, but it also returns potentially valuable resources to the land where they can be recycled.

GENERAL PRINCIPLES

Sewage sludge is derived from the organic and inorganic matter removed from wastewater at sewage treatment plants. The nature of sludge depends on the wastewater sources and the method of wastewater treatment. If waste solids are to be evaluated as a soil amendment or as a fertilizer, it is important to understand their chemical and biological properties.

Although sludge contains solids, the problem of its disposal is not primarily a solid waste problem; it is rather the problem of disposing of the water that is in close association with waste solids. The major part of the cost of sludge treatment and disposal is directly related to the tons of water associated with each ton of solids. A typical digested sludge contains about 20 tons of water for each ton of solids. A dilute, waste-activated sludge from biological treatment may contain well over 100 tons of water per ton of solids.

The nitrogen content of sludge usually limits its rate of application to land as a fertilizer, this content varying from 2 to 8 percent. Thus, 5 tons per acre per year of dry sludge solids may provide 200 to 800 pounds of nitrogen per acre per year, within the range of requirements for some natural and most cultivated crops. On the other hand, where sewage sludge is applied to land for the purpose of disposal rather than fertilization, there is a tendency to apply as large a quantity of sludge as is physically possible. A recent U. S. Department of Interior report recommended sludge application rates of 10 to 40 tons of dry solids per acre, corresponding to 400 to 6400 pounds of nitrogen per acre, generally well beyond crop requirements.

It is apparent from the above discussion that one potential problem associated with disposal of liquid sludged on land will be an excess of nitrogen above that which the growing crop can assimilate. If nitrification of the excess ammonium nitrogen originally present or subsequently mineralized occurs and NO_3 moves through the soil profile, considerable nitrate enrichment of groundwater or surface waters may occur.

Land application of sewage sludge is often compared to application of manure. The manuring effect of sewage sludge is good, but different from that of rotted animal manure. The latter is nearby foolproof; the nutrients are in good balance, and in the soil their availability to plants proceeds slowly, according to the progress of decomposition and transformation. One ton of an average farm manure is considered to supply as much nitrogen, phosphorus, and potassium as 100 pounds 10-5-10 fertilizer. (Throughout this Chapter, the use of X-Y-Z will refer to precent by weight of N, P_2O_5, and K_2O, respectively.) This assumes an average manure composition of 0.5 percent N, 0.25 percent P_2O_5, and 0.5 percent K_2O, emphasizing again the relatively low nutrient analysis of manures. However, since field rates of manure application are commonly 10-15 tons per acre per year, the total nutrients supplied under practical conditions are substantial and sometimes more than needed for optimum growth.

In sewage sludge, the ratio of nutrients is unbalanced. There is, in general, a deficiency in potassium, and a greater portion of the total nitrogen content is inorganic (and hence more rapidly released). These differences from stable manure and sometimes additional special characteristic properties must be taken into consideration in order to avoid negative yield results and to achieve maximum positive effects when applying sewage sludge.

Careful attention must be paid to enrichment, that is, improvement and accumulation, for this is sometimes synonymous with pollution. The enrichment or accumulation happens in the upper soil layer, for the subsoil has a very much lower holding capacity. The upper layer is the main space for the root system; it is the humus horizon. This layer is of different thickness in different soils, depending on soil development, which in farm land is influenced to a high degree by the kind and quality of soil management.

Although the use of sewage sludge for its fertilizer value has many potential benefits, the delivery of sludge for agricultural use may be more advantageous to the sludge

producers than to farmers. The farmer is confronted with sludge of different characteristics -- wet, moist, or dry; liquid, sticky, or crumbly; odorus --that depend on the processing of the raw sludge. The farmer evaluates the product delivered to him according to the necessary input of labor, and according to its manuring effects.

On the other hand, there are presently serious shortages of nitrogen and phosphorus fertilizers. The price of ammonia in the past few years has increased about 4 times, and phosphorus has increased about 3 1/2 times. The price of anhydrous ammonia has increased from $90 to $350 per ton and phosphorus has gone from $100 to almost $350 per ton. This has produced a change in the farmer's attitude toward sludge. Many farmers are now much more willing to accept sludge, especially for its phosphorus content. What the farmer cannot judge is the pollution potential of sludge application, which depends on waste collection and sludge treatment outside his influence and responsibility. For instance, pathogenic organisms, carcinogenic or toxic substances, and heavy metals in sludge may all contribute to surface or ground water pollution if land application is practiced.

The physical, chemical, and microbiological characteristics of the sludge, as well as the actual quantities, will depend on the nature of the raw sewage for the area in question, the methods of sewage treatment, and the methods of sludge processing at the treatment plant. Digested sludge has been shown to be toxic to germinating corn. Ammonia has been identified as one of the toxins, but not the only one. Anaerobic decomposition of organic waste also produces volatile organics which are toxic to plant roots and seedlings. Aging digested sludge or delaying applications for about 3 weeks after planting of the crop (to allow germination) should prevent the problem.

For health considerations, only digested sludge should be used on croplands. No known cases of human or animal disease have been reported with use of digested sewage sludge.

APPLICATION TECHNIQUES FOR SEWAGE SLUDGE

The manner by which sludge is applied to land will greatly affect how it is assimilated. Sludge can be applied to the land in several ways: spray application of sludge may be best in some instances while spreading followed by cultivation may be the best in other cases. Furrow application may also be used, particularly if rows of trees of other plants are situated along contours of steeply sloping land.

There are two basic categories of equipment for application of sewage sludge--fixed and movable. The most common types of equipment are tank trucks with various means of spreading by gravity or pumping. Fixed and movable spray pipes have also been used. Application equipment is perhaps the most significant opportunity for innovative ways to minimize costs and maximize the application season. Knifing into the soil has been tried and is a promising technique for arable soils. On fields with many rocks near the surface, though, the rocks tend to break the injection mechanism. This technique usually cannot be used when crops are growing.

The most economical method of disposal is pumping sludge from the digestor at the STP into a tank truck and hauling it to the farm fields, pastures, grasslands, and forests. The use of earth-moving type equipment for application enables vehicles to get on fields in bad weather while minimizing compaction. High flotation (balloon) tires also permit the vehicles to be used over rough terrain or in fields during adverse weather conditions.

SITE CONSIDERATIONS

Slope

A 5 to 8 percent slope is usually considered as a safe maximum grade for the land application of sewage sludge, dependent on the rate of application, cover crop, and the possibility of either collection of treatment of runoff.

Soils

Soils differ greatly in their ability to assimlate sludges. Soils vary widely in permeability, pH, water table location, adsorption capacity, organic content, ion exchange, and chemical precipitation capability.

Basically, it can be stated that application rates in any soil should be subjected to good record keeping and careful monitoring. Overloading of a particular soil is a major reason for failure. Caution should be used in dealing with acid soils due to the possible release of heavy metals. The general rule is to maintain a pH above 6.5 to control heavy metal solubility.

Rate of Application

In the range of 5 to 10 dry tons per acre per year, no commercial fertilizer, with the exception of potassium, should generally be necessary. The rate of sludge decomposition might vary considerably when applied by surface irrigation, soil incorporation, deep plowing, or injection. Likewise, the expected rate of sludge decomposition will differ when applied in a single massive application versus repeated smaller additions. Frequent large applications of sewage sludge or single massive applications could result in an accumulation of organic matter which would adversely affect ion solubility and availability, plant growth, or environmental quality. Thin applications of liquid sludge on the soil surface have not resulted in reductions in water infiltration if the sludge dried between applications.

Incorporation into the soil is essential for rapid decomposition of sludge because it helps maintain the moisture content within the range favorable for microbial activity and ensures the presence of a large and heterogenous soil microbe population.

Plant uptake of nitrogen varies greatly, but may be 150 to 250 pounds per acre for corn crops and more for other grasses.

Crops

Corn is perhaps the best and most widely used crop, having the advantage of high nitrogen uptake and good commercial value. The other general-purpose group of crops are the forage grasses such as timothy, reed canary, rye, red top, fescue, and sudan grass. Perhaps the best of these is reed canary which has good nitrogen uptake and is a hearty perennial. The biggest advantage of these grass crops, in addition to nitrogen uptake, is the ability to get on them for sludge application when other crop land cannot be accessed. This includes times of inclement weather, early spring, late fall before the soil cools down, and during the active growing season when other crops restrict tank truck operations.

RECOMMENDATIONS

Based on the preceding discussion, it was concluded that land application of sludge is feasible in the Bicounty Area. Such a program could be promoted on the basis of soil enhancement. Pastureland, cropland, and forestland can be used, as long as the land scopes are less than about 8 percent. Gentle slopes should prevent the rapid washoff associated with steeper slopes during heavy rains. Recommended application rates and frequencies were determined to be as follows:

a. Pastureland: 5,000 gallons/day/acre -- 5 times during the year; on the surface before vegetation -1 time; after every cutting -- 3 times; late fall -- 1 time.

b. Cropland (corn for silage): 5,000 to 8,000 gallons/day/acre --4 times during the year; incorporate into the soil in May -- 8,000 gallons/day/acre; during vegetation period side dressing between or beside the crop rows; June (late) -5,000 gallons/day/acre; July (late) -5,000 gallons/day/acre; incorporated into the soil in October -- 7,000 gallons/day/acre.

c. Forest: 2,500 gallons/day/acre--surface application 10 times during vegetation season; one day in every second or third weed (April to October).

At the above recommended rates (about 5 dry tons per acre per year), the sludge would furnish between 250 to 500 pounds of nitrogen, 250 pounds of phosphorus, and 50 pounds of potassium. This rate equals about 3,000 pounds per year of 17-20-3 (N-P2O5-K2O) fertilizer. Tank trucks are recommended for applying the sludge because of their economy relative to other more capital intensive techniques and because of their mobility in applying sludge to scattered sites across the two counties. Selection of potential application sites is presented in subsequent sections.

LAND APPLICATION OF SECONDARY EFFLUENT

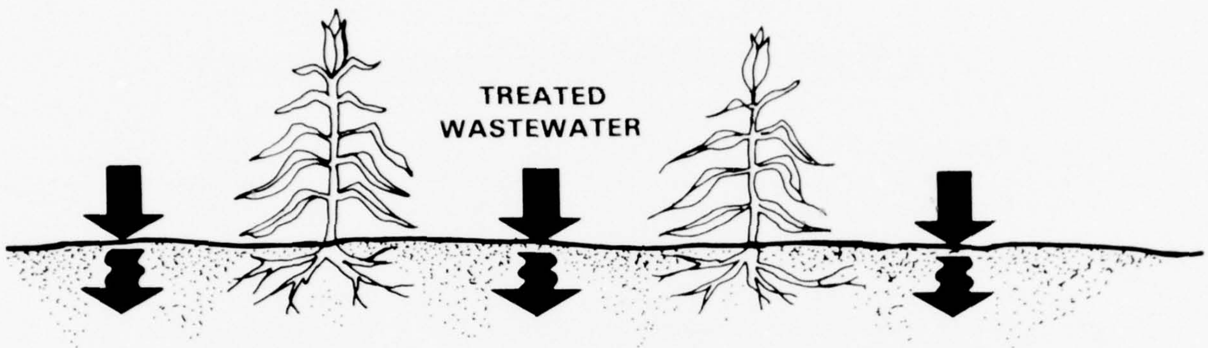
Although sewage sludge contains many of the solids and nutrients originally contained in raw wastewater, secondary treated effluent still retains a percentage of matter that may be objectionable when discharged to waterways. Several treatment processes (commonly labeled advanced waste treatment) can remove these remaining pollutants, especially nutrients and suspended solids. However, these pollutants are sometimes considered merely as "resources out of place." Land application of secondary effluent offers the opportunity to recover such resources by recycling them on the land. In dry regions, the water itself may be a valuable resource for irrigation purposes. In regions with poor soils, wastewater nutrients can help sustain better crop yields with less fertilizer.

GENERAL PRINCIPLES

The land application process outlined on Figure V-1 uses the entire biosystem, including the soil and vegetative or crop cover, to purify the secondary effluent. The effluent is renovated primarily by four basic internal mechanisms operating within the soil, namely filtration, plant uptake, cation exchange and fixation, and volatilization. These mechanisms are active to some degree in all types of soil and control the effectiveness of the land to sustain optimum crop production.

Filtration is the physical retention by soil acting as a screening process of the suspended solids in the secondary effluent. The effectiveness of the soil as a filter depends upon the soil

LAND APPLICATION OF SECONDARY EFFLUENT

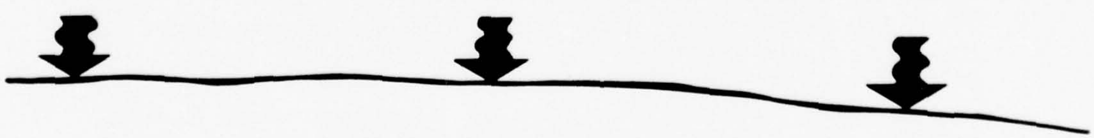


ROOT SYSTEMS - TAKE UP SOLUBLE NUTRIENTS

SOIL PARTICLES - MECHANICALLY STRAIN SUSPENDED SOLIDS

- ADSORB BACTERIA, VIRUSES, PHOSPHORUS, AND HEAVY METALS

SOIL MICROORGANISM - CONSUME DISSOLVED ORGANIC, NITROGENOUS AND PHOSPHORUS MATERIALS



ZONE OF SATURATED SOIL

FIGURE V-1

particle size and distribution. Most of the suspended solids are organic in nature and are primarily decomposed by the microorganisms in the soil. It is this residue which is retained in the soil column.

The plant uptake mechanism relies on the root system to adsorb portions of the available nutrient elements from the wastewater. In order for the plants to utilize these nutrients, however, they have to be in forms that make them readily available for uptake. As with commercial fertilizer, nutrients such as nitrogen and phosphorus in the wastewater will be transformed by complex biological and chemical processes from the applied form to a usable soil form. Nitrogen in ammonium form is mostly converted by the soil microorganisms to nitrate form before being ultimately absorbed. Nitrogen also may be lost by evaporation of ammonia or reduction of nitrate to inert nitrogen gas.

The conversion to gaseous form, called volatilization, is an integral part of the normal nitrogen cycle and under certain circumstances, is an important factor in the ultimate loss of a significant amount of the applied nitrogen. Under aerobic (aerated) conditions, soil organisms degrade organic matter with the release of carbon dioxide gas and water.

Cation exchange is a key part of the uptake mechanisms. Through ion exchange, soils have the capability to temporarily hold certain dissolved, positively charged (cations) chemicals in the wastewater. These chemicals are adsorbed by the negatively charged clay minerals and organic matter in the soil. The quantity of positively charged ions that a soil is able to hold is dependent upon its "Cation Exchange Capacity" which in turn is primarily determined by the type and quantity of the clay minerals, the amount of organic matter and soil pH. Because of differences in ion charge, those dissolved chemicals which have a greater ion strength will usually be preferentially adsorbed, thereby replacing those of lesser strength. This mode of holding is responsible for the retention of calcium magnesium, and potassium against leaching until such time as they are adsorbed by plant roots. Ammonium nitrogen is similarly held in the soil until converted by nitrifying microorganisms to nitrate nitrogen which can either be adsorbed by the plant or lost to drainage.

Soils also have the capacity to retain certain other dissolved chemicals very tightly through adsorption. This mechanism called "fixation" results from either very strong physical or chemical processes, pH dependent absorption processes,

and/or chemical precipitation. Compounds of iron, aluminum, and/or calcium contained in the soil are primarily responsible for the fixation of such elements as phosphorus and trace metals in the soil. The fixed phosphorus and trace metals being in an insoluble form are thus held and not leached from the soil. However, fixation is not necessarily synonomous with total unavailability.

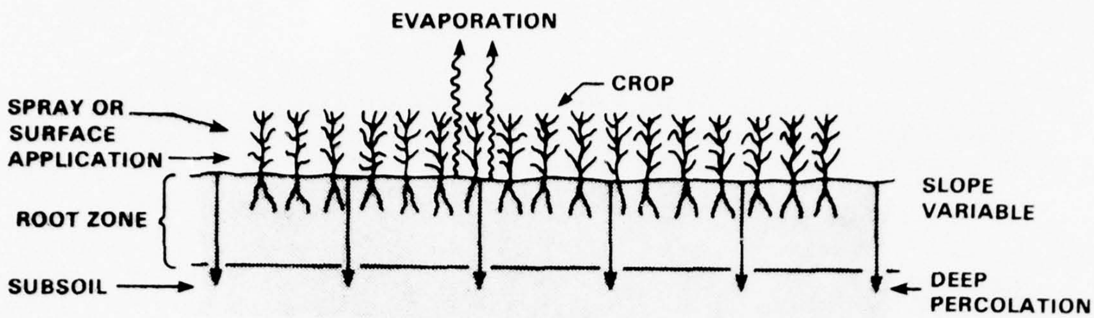
The extremely small percent of the pathogens and viruses that remain after chlorination of secondary effluent are filtered out by the soil and then degraded by the soil microorganisms. Similarly, the oils and grease which have not been removed during primary and secondary treatment will form films on the soil particles and then be degraded by microbial action.

Nitrogen is the critical chemical element in the design of a land application system. The concentration and the degree of removal is controlled by several conversion processes within the soil. Nitrogen in the wastewater occurs primarily in the form of ammonium which is converted by the soil's microorganisms into the nitrate form for uptake by the cover crop. The rate at which the soil bacteria convert the ammonium nitrogen to nitrate form depends upon a range of physical factors, especially the soil's temperature and pH. In the presence of a large supply of energy materials such as carbon or crop residue much of the nitrogen may be temporarily incorporated into new microbial cells. Then as the crop residue is decomposed, many of the microorganisms die and the nitrogen in the bodies is recycled for crop use.

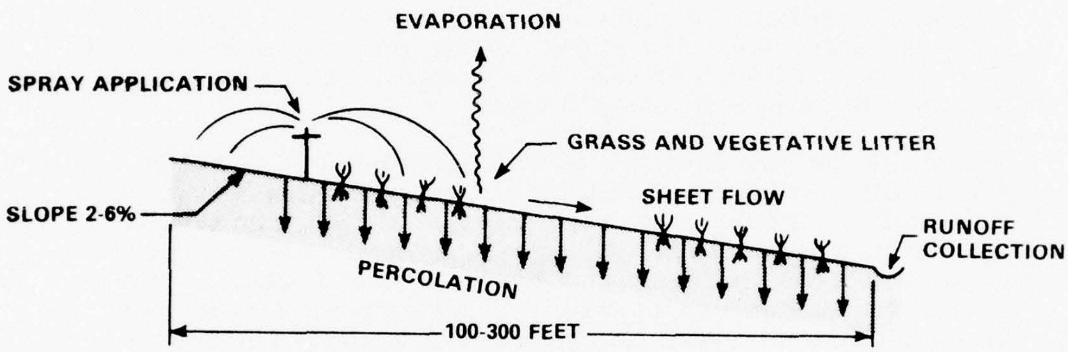
Understanding the nitrogen cycle is critical to the design of the land treatment system. The application rate and schedule must be framed to coincide with the crop's nitrate uptake requirements, taking advantage of the soil's microbial capability to immobilize the nitrogen until needed. This should provide top yields and facilitate maintaining a continuously balanced fertility program, assuming the climate conditions permit.

APPLICATION TECHNIQUES FOR SECONDARY EFFLUENT

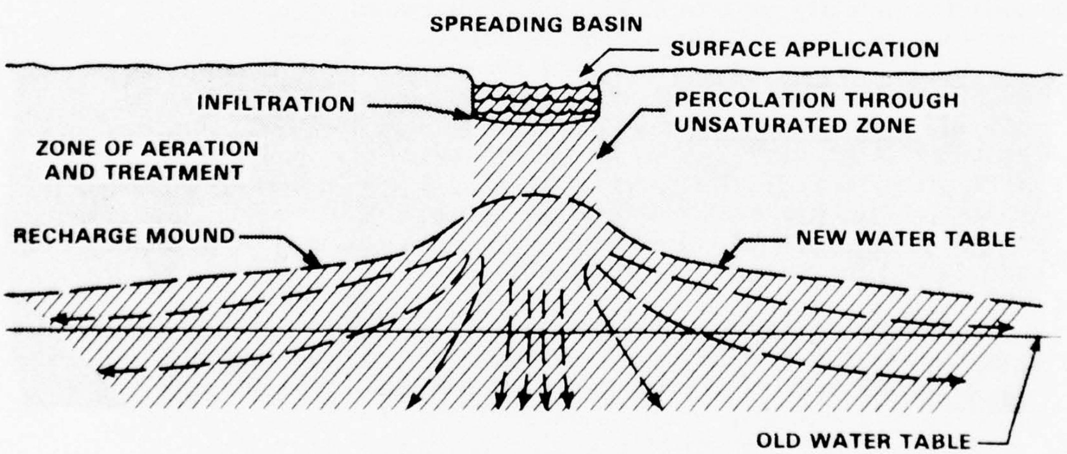
Three distinct techniques are available for applying secondary effluent to the land: crop or forest irrigation, overland flow, and rapid infiltration/percolation (see Figure V-2).



(a) IRRIGATION



(b) OVERLAND FLOW



(c) INFILTRATION-PERCOLATION

LAND APPLICATION TECHNIQUES FOR SECONDARY EFFLUENT

FIGURE V-2

Each technique requires certain characteristics at the application site for successful operation and these characteristics will be discussed in the following paragraphs.

Irrigation

Crop or forest irrigation systems may embody various methods of applying secondary treated effluents to the land. Spray irrigation may be accomplished using a variety of systems from portable to solid-set sprinklers. Ridge and furrow irrigation consists of applying water by gravity flow into furrows while crops are grown on the flat ridges between the furrows. Flood irrigation is accomplished by inundation of land with several inches of water.

The major factors involved in site selection are: the type, drainability, and depth of soil; the nature, variation of depth, and quality of groundwater; the location, depth, and type of underground formations; the topography; and considerations of public access to the land. Climate is as important as the land in the design and operation of irrigation systems. In site selection, however, climate is not a variable since most economically feasible sites will be located within a limited transmission distance from the source.

Soil drainability is a primary factor because, coupled with the type of crop or vegetation selected, it directly affects the liquid loading rate. A moderately permeable soil capable of infiltrating approximately 2 inches per day or more on an intermittent basis is preferable. In general, soils ranging from clay loams to sandy loams are suitable for irrigation. Soil depth should be at least 2 feet of homogenous material and preferable 5 to 6 feet throughout the site. This depth is needed for extensive root development of some plants and for wastewater renovation.

The minimum depth to groundwater should be 5 feet to ensure aerobic conditions. If the native groundwater is within 10 to 20 feet of the surface and site drainage is poor, control procedures, such as underdrains or wells, may be required. If the groundwater quality is significantly different from the renovated water quality, control procedures may again be necessary to prevent intermingling of the two waters.

For crop irrigation, slopes should be limited to about 10 percent or less depending upon the type of farm equipment

to be used. Forested hillsides up to 30 percent in slope have been spray irrigated successfully.

A suitable site for wastewater irrigation would preferably be located in an area where contact between the public and the irrigation water and land is controlled. Landscape irrigation, however, often makes this condition difficult.

Important rates are liquid loading in terms of inches per week and nitrogen loading in terms of pounds per acre per year. Organic loading rates are less important provided that an intermittent application schedule is followed. Liquid loadings may range from 0.5 inches per week to 4.0 inches per week, depending on the soil, crop, climate, and wastewater characteristics. Crop requirements generally range from 0.2 to 2.0 inches per week, although a specific crop's water needs will vary throughout the growing season. Typical liquid loadings are from 1.5 to 4.0 inches per week.

Nitrogen loading rates must be calculated because of nitrate buildup in soils, underdrain waters, and groundwaters. To minimize such buildup, the pounds of total nitrogen applied in a year should not greatly exceed the pounds of nitrogen removed by crop harvest. For example, an effluent containing 20 mg/l of nitrogen applied at 5 ft/year would equal a nitrogen loading rate of 270 lb/acre/year. If the irrigated crop takes up only 150 lb/acre/year, most of the excess nitrogen will leach to the subsoil and ultimately to the groundwater. In most cases, with loamy soils, the permissible liquid loading rate will be the controlling factor; however, for more porous, sandy soils, the nitrogen loading rate may be the controlling factor.

Crop selection can be based on several factors: high water and nutrient uptake, salt or boron tolerance, market value, or management requirements. Grasses with high year-round uptakes of water and nitrogen and low maintenance requirements are popular choices. To ensure the die-off of anaerobic bacteria, an aerobic zone in the soil is necessary. A drying period ranging from several hours each day to several weeks is required to maintain aerobic soil conditions. The length of time depends upon the crop, the wastewater characteristics, and the length of the application period. A ratio of drying to wetting of about 3 or 4 to 1 should be considered as a minimum.

Renovation of the wastewater occurs generally after passage through the first 2 to 4 feet of soil. Removals are found to be on the order of 99 percent for BOD, suspended solids, and fecal coliforms. As irrigation soils are usually loamy

with considerable organic matter, the heavy metals, phosphorus, and viruses are retained in the soil by adsorption and other mechanisms. Nitrogen is taken up by plant growth, and if the crop is harvested, the removals can be on the order of 90 percent.

Overland Flow

An overland flow system is used for soils with very low infiltration and/or percolation capacities. Wastewater renovation by the overland flow system requires the filtering action of a close growing vegetation, generally adaptable grasses, and the controlled flow of a thin film of wastewater over the soil surface to maximize activity between the wastewater pollutants and soil microbiological and physical/chemical processes at the soil-water interface.

Soils with limited drainability, such as clays and clay loams, are suited to overland flow. The land should have a slope between 2 and 6 percent and a very smooth surface so that the wastewater will flow in a sheet over the ground surface. Slopes greater than 6 percent can be used successfully but may introduce problems, such as erosion, and difficulties in using farm machinery. Grass is planted to provide a habitat for the bacteria which provide the renovation. As runoff is expected, a suitable means of final disposal should be provided.

Because groundwater will not likely be affected by overland flow, it is of minor concern in site selection. The groundwater table should be deeper than about 2 feet, however, so that the root zone is not waterlogged.

Systems are generally designed on the basis of liquid loading rates, although an organic loading or detention time criterion might also be important. The process is essentially biological with a minimum contact time between bacteria and wastewater required for adequate treatment. Liquid loading rates used in design have ranged from 2.5 to 5.5 in/week, with a typical loading being 4 in/week for food processing wastewater.

Important management practices are: maintaining the proper hydraulic loading cycle; maintaining an active biota and a growing grass; and monitoring the performance of the system. Hydraulic loading cycles, or periods of application followed by resting, have been found to range from 6 to

8 hours of application followed by 7 to 18 hours of drying for successful operations. Periodic cutting of the grass with or without removal is important, and monitoring is needed to maintain loading cycles at optimum values for maximum removal efficiencies.

Overland flow systems have been monitored to determine removal efficiencies. The expected ranges are BOD and suspended solids removals of 95 to 99 percent, nitrogen removals of 70 to 90 percent, and phosphorus removals of 50 to 60 percent. Removal of solids and organics is by biological oxidation of the solids as they pass through the vegetative litter. Nutrient removal mechanisms include crop uptake, biological uptake, denitrification, and fixation in the soil.

Infiltration-Percolation

Rapid infiltration-percolation systems are used where deep permeable soil materials are available. The rapid infiltration-percolation basins renovate a few to several hundred feet of water per year by proper management. Proper management implies alternating flooding and drying periods to manipulate the soil microbiological mass, promoting nitrification and denitrification processes and the decomposition of organic materials filtered out of the wastewater at the soil surface. Degrading accumulated organic materials by aerobic microorganisms during the drying cycle facilitates restoration of the water infiltration capacity of the soil filter. Sometimes grass is grown in the basins to aid in maintaining infiltration capacities during the flooding cycle.

Soils with infiltration rates of 4 in/day to 2 ft/day, or more, are necessary for successful use of the infiltration-percolation approach. Acceptable soil types include sand, sandy loams, loamy sands, and gravels. Very coarse sand and gravel is not ideal because it allows wastewater to pass too rapidly through the first few feet where the major biological and chemical action takes place.

Other factors of importance include percolation rates, depth, movement and quality of groundwater, topography, and underlying geologic formations. To control the wastewater after it infiltrates the surface and percolates through the soil matrix, the subsoil and aquifer characteristics must be known. Recharge should not be attempted without specific

knowledge of the movement of the water in the soil system and the groundwater aquifer.

There are two ranges of liquid loading rates, moderate and high, depending upon the loading objective. For direct recycling of wastewater to the land by infiltration-percolation, liquid loading rates range from 4 to 60 in/week. Organic loading rates are generally of secondary importance for moderate rate systems.

For high rate systems, liquid loadings range from 5 to 10 feet/week. Organic loading rates range from 3 to 15 tons of BOD/acre/year. Municipal high rate infiltration-percolation systems generally pretreat the wastewater to secondary quality to maintain high liquid loading rates. Industries have tended to rely more on the assimilative capacity of the soil, and thus have generally used pretreatment only to avoid operational problems.

Important management practices include maintenance of hydraulic loading cycles, basin surface management, and system monitoring. Intermittent application of wastewater is required to maintain high infiltration rates, and the optimum cycle between inundation periods and resting periods must be determined for each individual case. Basin surfaces may be bare, covered with gravel, or vegetated. Each type requires some maintenance and inspection for a satisfactory operation. Monitoring, especially of groundwater levels and quality, is essential to system management.

Removals of constituents by the filtering and straining action of the soil are excellent. Suspended solids, fecal coliforms, and BOD are almost completely removed in most cases. Nitrogen removals are generally poor unless specific operating procedures are established to maximize denitrification. Phosphorus removals range from 70 to 90 percent depending on the physical and chemical characteristics of the soil that influence retention of phosphorus.

RELIABILITY OF APPLICATION TECHNIQUES

Table V-1 lists the comparative characteristics for the three major application techniques of irrigation, overland flow, and infiltration-percolation systems.

TABLE V-1

COMPARATIVE CHARACTERISTICS OF IRRIGATION, OVERLAND FLOW, AND INFILTRATION-PERCOLATION SYSTEMS

Factor	Irrigation	Overland Flow	Infiltration-Percolation
Liquid loading rate	0.5 to 4 in./wk	2 to 5.5 in./wk	4 to 120 in./wk
Annual application	2 to 8 ft/yr	8 to 24 ft/yr	18 to 500 ft/yr
Land required for 1-mgd flow	140 to 560 acres plus buffer zones	46 to 140 acres plus buffer zones	2 to 62 acres plus buffer zones
Application techniques	Spray or surface	Usually spray	Usually surface
Soils	Moderately permeable soils with good productivity when irrigated	Slowly permeable soils such as clay loams and clay	Rapidly permeable soils, such as sands, loamy sands, and sandy loams
Probability of influencing groundwater quality	Moderate	Slight	Certain
Needed depth to groundwater	About 5 ft	Undetermined	About 15 ft
Wastewater lost to:	Predominantly evaporation or deep percolation	Surface discharge dominates over evaporation and percolation	Percolation to groundwater

Reliability of land application involves considerations of long term use, wastewater renovation, and minimization of adverse environmental impacts. Unlike mechanical treatment facilities, land application facilities do not have a fixed expected useful life. The useful life depends upon factors such as the management, the soil, the climate, and the wastewater characteristics. Also, changing land use needs and wastewater management objectives affect the expected life of a system.

Wastewater irrigation has proven to be reliable in terms of long useful life. With proper management, degradation of groundwater and health risks can be avoided. Irrigation has had many positive effects on the environment, such as improving soil conditions, and providing wildlife habitats.

Removal efficiencies are also quite good for overland flow. As it is a biological process, a period of intermediate treatment will occur before the biota are fully established. Renovation of wastewater by overland flow is only slightly less complete than that for irrigation, the major exception being being a rather low removal of phosphorus. Adverse environmental effects from overland flow systems should be minimal. As a runoff flow is collected, it must be either stored and reused or discharged to a surface watercourse. Because infiltration into the soil is slight, the changes of affecting groundwater quality are minimal. Build up of salts may occur over time, depending on the operation, but these would have little effect on other aspects of the environment.

The useful life of an infiltration-percolation system will be shorter, in most cases, than that for irrigation or overland flow. This is caused by higher loadings of inorganic constituents, such as phosphorus and heavy metals, and the fact that these constituents are fixed in the soil matrix and not positively removed. Therefore, exhaustion of the fixation capacity for phosphorus and heavy metals will be a function of the loading rate and the fixation sites available. The degree of wastewater renovation achieved by infiltration-percolation varies considerably with the soil characteristics and management practices. Overall nitrogen removal, taking into account the high nitrate concentration flushed to the groundwater at the beginning of inundation, averages 30 percent. Removals of phosphorus and heavy metals are also generally less than for irrigation. From the standpoint of environmental effects, infiltration-percolation has demonstrated the least amount of reliability of the three approaches. Most systems that have been monitored and managed properly, however, are quite reliable in this regard. Infiltration-percolation also has the advantage of providing a tertiary level of treatment at a relatively low cost.

DETERMINATION OF APPLICATION CRITERIA

In determining the appropriate application rate for secondary effluent, the various techniques were compared in light of possible application sites. Furthermore, an appropriate application season was determined followed by recommendation of a reliable rate of application.

Application Technique

Irrigation, overland flow, and infiltration-percolation have many common aspects, but many different factors must be considered in selecting among them. Objectives for wastewater management are listed in Table V-2 along with the capabilities of each approach in meeting them. As indicated, irrigation provides considerable renovation; however, the major portion of the effluent applied is lost to evapotranspiration. Unless excess irrigation water is applied and underdrains or recovery wells are used, the approach is impractical as a means of reclaiming effluent water.

Physical aspects of the available land, such as soil type, underground formations, and ground slope, will influence the approach selection. Other technical factors include wastewater characteristics and flow rates, climate, and whether the flow remains constant throughout the year. For seasonal flows, such as those from canneries, the selection of the overland flow system, like any biological system, must take into account an annual startup period. Soil classification, an important independent variable, has been graphed against liquid loading rates as the dependent variable. The resultant combinations are indicated in Figure V-3 for the typical ranges for each land application technique. This graph is intended as a general aid for the selection of an application technique.

For Broome and Tioga Counties, the infiltration-percolation technique was discarded immediately because of the necessity for highly permeable soils and a deep groundwater table. Neither of these two criteria are met in the Bicounty Area.

Overland flow and irrigation were subsequently investigated to find the most acceptable application technique. Initially, an application rate between 1 and 2 inches per week (subsequently determined to be 1.7 inches/week) was assumed as a realistic value for the Bicounty Area, based on climate, soils, and topography.

TABLE V-2

OBJECTIVES OF IRRIGATION, OVERLAND FLOW, AND INFILTRATION-PERCOLATION FOR MUNICIPAL WASTEWATER

	Type of Approach		
Objective	Irrigation	Overland Flow	Infiltration-Percolation
Use as a treatment process with a recovery of renovated water	Impractical	50 to 60% recovery	Up to 90% recovery
Use for treatment beyond secondary:			
1. For BOD and suspended solids removal	90-99%	90-99%	90-99%
2. For nitrogen removal	Up to 90%	70-90%	0-80%
3. For phosphorus removal	80-99%	50-60%	70-95%
Use to grow crops for sale	Excellent	Fair	Poor
Use as direct recycle to the land	Complete	Partial	Complete
Use to recharge groundwater	0-30%	0-10%	Up to 90%
Use in cold climates	Fair	--	Excellent

SOIL TYPE VERSUS LIQUID LOADING RATES FOR DIFFERENT LAND APPLICATION TECHNIQUES

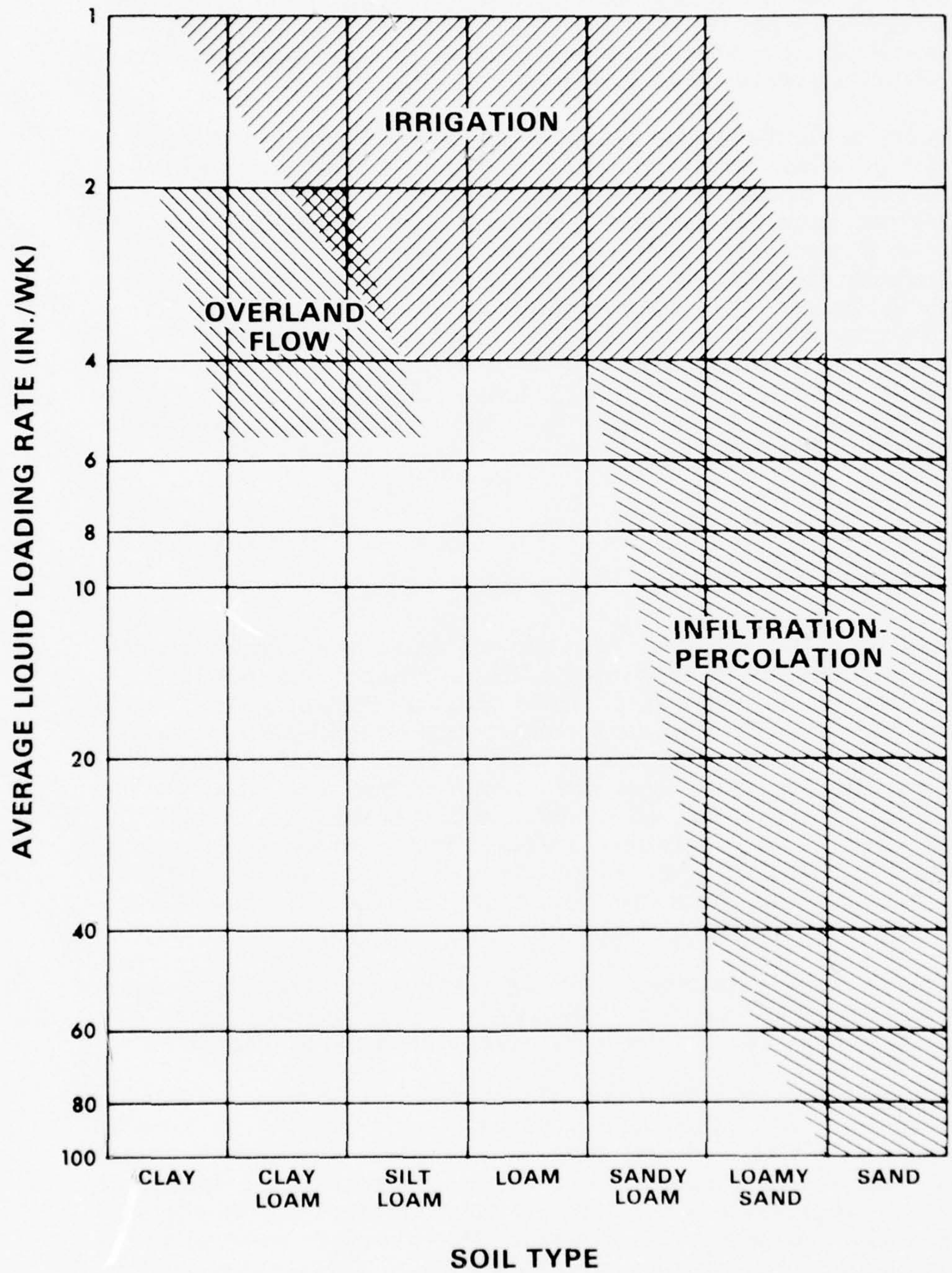


FIGURE V-3

With this assumed value and the fact that silt loams comprise the greatest percentage of upland soils at the recommended sites (see later section), Figure V-3 was used as a guide for selecting an appropriate application technique. Irrigation appeared as the most favorable choice, although overland flow should be considered if the application rate could be greater than 2.0 inches per week.

Spray irrigation also appeared to be more feasible because of the rolling to steep terrain, general poor drainage, and forested areas of the upland regions. The overland flow method requires uniformly sloping land of a small gradient (2 to 6 percent), usually not available except in scattered pockets distributed across the recommended sites. Later investigation also showed that the amount of land modification required by overland flow would make the costs of such a system significantly higher than spray irrigation. For these reasons (soils, topography, climate, costs), spray irrigation was recommended as the technique for land application of secondary effluent.

Application Season

Realizing that climate is also an important consideration when proposing a land application system for secondary effluent, climatological records for the Bicounty Area were examined to determine a suitable spray application season. Broome and Tioga Counties have a cool, humid, continental type climate. Summers are usually cool and short while winters are long and cold, with periods of changeable weather. The geographic location and local topography frequently result in varying climatological conditions. Official climatological data are observed at the Broome County Airport in the Town of Maine.

The average minimum, average maximum, and mean monthly temperatures for 1952-1973 in the Bicounty Area are summarized in Table V-3, and presented in Figure V-4.

Summer temperatures occasionally reach 90 degrees Farenheit (F), but the daily average temperature is usually between 62 and 75 degrees F. The highest winter daytime temperatures average from 32 to 36 degrees F, while the lowest nighttime temperatures range from 15 to 20 degrees F. The temperature may reach 0 degrees F several times a season, but temperatures much below this seldom occur.

TABLE V-3

MONTHLY TEMPERATURE (°F)

MAXIMUM, MINIMUM, AND MEAN[1]

MONTH	AVERAGE MAXIMUM	AVERAGE MINIMUM	MEAN VALUE
January	28.1	13.5	20.8
February	30.1	15.3	22.7
March	38.0	23.7	30.9
April	53.4	35.2	44.3
May	64.3	45.0	54.7
June	74.2	54.8	64.5
July	78.2	59.3	68.8
August	76.4	57.6	67.0
September	69.3	51.0	60.2
October	58.4	41.0	49.7
November	44.5	31.4	38.0
December	32.3	20.2	26.3

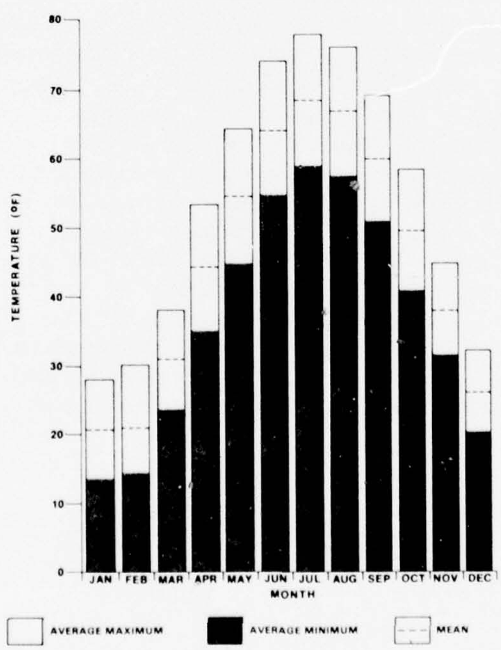
[1] 1952-1973 data

Source: U.S. Department of Commerce, NOAA, 1973 Local Climatological Data, Annual Summary with Comparative Data, Binghamton, New York.

MONTHLY TEMPERATURES (°F)

MAXIMUM, MINIMUM, AND MEAN

(1952 - 1973)



SOURCE: U.S. Department of Commerce, NOAA, 1973 Local Climatological Data Annual Summary with Comparative Data for Binghamton, New York.

FIGURE V-4

The freeze-free period averages about 150 days, less than half a year. The average data for the last freezing temperature in spring is the first week in May and the average time for the first freeze in autumn is the last week in October. Freezing temperatures have been recorded as late as 19 May, and as early as 14 September.

The total annual precipitation of 37.35 inches is uniformly distributed throughout the year although the greatest average monthly rainfall occurs during the growing season of April through September. Thunderstorms are the source of most of the rainfall, with a normal year having 31 such storms. In an average year, 162 days receive some form of precipitation greater than 0.1 inch. Table V-4 and Figure V-5 present tabular and graphic analyses of the average maximum, average minimum, and mean monthly precipitation.

The average annual snowfall in the City of Binghamton is approximately 50 inches. However, the Broome County Airport, which is north-northwest of Binghamton and about 700 feet higher in elevation, has an average annual snowfall of approximately 88 inches. About half of the annual snowfall occurs during January and February, although snows can occur in early November and in late April. Table V-5 and Figure V-6 present the average maximum, the maximum in 24 hours, and mean monthly snowfall recorded during 1951-1973.

Because the average frost-free season is about 150 days and because snow will normally occur in the months from November through April, the land application of liquid effluent should be limited to a maximum of six months (May through October -- 26 weeks). Furthermore, the depth of the upper soil is inadequate for winter irrigation in Broome and Tioga Counties. Freezing temperatures and severe weather conditions could combine with the poor drainage and hilly terrain to cause ponding and rapid runoff as well as interference with equipment operation between November and April. For these reasons, and others as discussed in the Plan Formulation Appendix, land application of wastewater was investigated for the May through October period with secondary treated wastewater being discharged to the river during other times of the year.

TABLE V-4
MONTHLY PRECIPITATION (INCHES)
MAXIMUM, MINIMUM, AND MEAN[1]

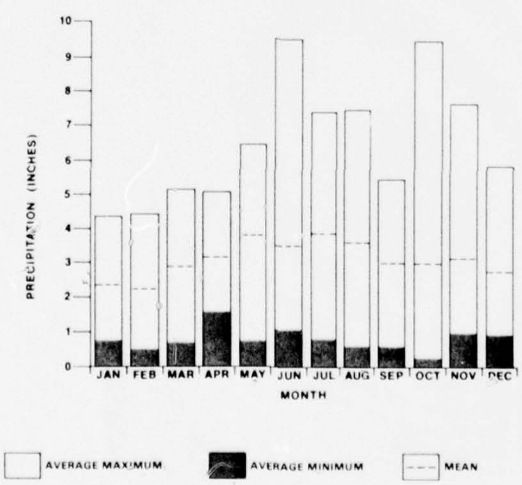
MONTH	AVERAGE MAXIMUM	AVERAGE MINIMUM	MEAN VALUE
January	4.31	0.76	2.32
February	4.36	0.51	2.25
March	5.11	0.69	2.87
April	5.09	1.61	3.18
May	6.46	0.78	3.83
June	9.46	1.15	3.59
July	7.40	0.83	3.83
August	7.48	0.61	3.61
September	5.47	0.61	3.02
October	9.43	0.26	3.00
November	7.62	1.01	3.10
December	5.81	0.94	2.75
Total Average Annual			37.35

[1] 1952 - 1973 data

Source: U.S. Department of Commerce, NOAA, 1973 Local Climatology Data Annual Summary with Comparative Data, Binghamton, New York.

MONTHLY PRECIPITATION (INCHES)

MAXIMUM, MINIMUM, AND MEAN
(1952 - 1973)



SOURCE U.S. Department of Commerce, NOAA, 1973 Local Climatological Data Annual Summary with Comparative Data for Binghamton, New York.

FIGURE V-5

TABLE V-5
MONTHLY SNOWFALL (INCHES)
MAXIMUM, MAXIMUM IN 25 HOURS, AND MEAN[1]

MONTH	AVERAGE MAXIMUM	MAXIMUM IN 24 HOURS	MEAN VALUE
January	36.6	18.4	18.9
February	44.3	23.0	20.4
March	33.5	15.8	15.5
April	16.4	11.5	5.1
May	3.4	3.4	0.4
June	0.0	0.0	0.0
July	0.0	0.0	0.0
August	0.0	0.0	0.0
September	TR	TR	TR
October	2.6	2.4	0.5
November	24.4	10.1	8.1
December	59.6	15.6	19.4
Average Annual			88.3

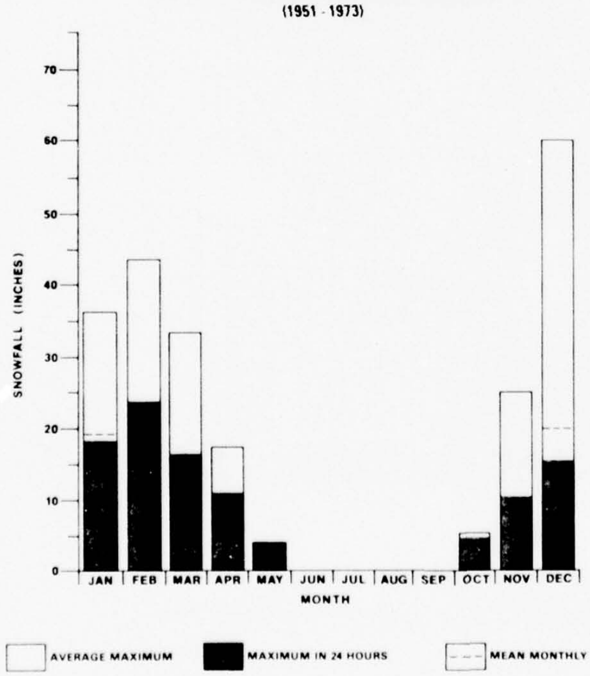
[1] 1951 - 1973 data

Source: U.S. Department of Commerce, NOAA, 1973 Local Climatological Data, Annual Summary with Comparative Data, Binghamton, New York.

MONTHLY SNOWFALL (INCHES)

MAXIMUM, MAXIMUM IN 24 HOURS, AND MEAN

(1951 - 1973)



SOURCE: U.S. Department of Commerce, NOAA, 1973 Local Climatological Data Annual Summary, with Comparative Data for Binghamton, New York

FIGURE V-6

Application Rate

Having recommended an application technique and an appropriate season, the application rate was then determined in conjunction with the specific sites described later in the Chapter. The presence of an adequate ground cover was an important consideration with spray application. The function of the ground cover was to protect the soil from erosion, shield the surface from droplet impact, provide for evapotranspiration of effluent, and increase the infiltration rates. Almost any soil and cover crop can benefit from sewage effluent when the application rate equals or is less than the evapotranspiration rate. Under these conditions, little if any effluent will have to penetrate the dense layer of fragipan commonly lying 1 to 2 feet below the surface of most upland soils in the Bicounty Area.

For Broome and Tioga Counties, weekly evapotranspiration has been estimated as a function of precipitation. Experimental results from Lysimeter tests were used along with local climatological data for the Binghamton area to arrive at Table V-6. The last column of this table estimates the weekly runoff or recharge values for various irrigation rates during the spray application season. Because the irrigation plus precipitation rates exceed evapotranspiration rates, the topography, soils, geology, hydrology, and other factors become more important in the selection of irrigation rates and sites to ensure sufficient and long term renovation of waste constituents.

The upland soils in Broome and Tioga counties have been considered to be the only ones where irrigation is feasible. Valley soils are too restricted in areas and too close to ground and surface water resources. The upland soils have minimum infiltration rates of 0.05 to 0.30 in/hour. Thus, even soils at the lower end of this range have a calculated recharge capacity of 8 in/week, well above that required in Table V-6. However, the following points must be emphasized:

a. The above infiltration rates only define the ability of the upper soils to transmit water. The infiltration rates of the fragipan are not actually known, but can be expected to be much lower.

b. All of the rates discussed are average rates; actual rainfall, for example, occurs over perhaps several hours each week, so that runoff may easily occur during short periods.

TABLE V-6
ESTIMATION OF EVAPOTRANSPIRATION
FOR BROOME AND TIOGA COUNTIES.

IRRIGATION(I) (in./week)	PRECIPITATION(P) (in./week)	I + P (in./week)	EVAPORATION(E) (in./week)	RECHARGE OR RUNOFF(R) (in./week)
1. May (precipitation 3.83 inch/month)				
0"	0.87	0.87	0.70	0.17
1"	0.87	1.87	1.50	0.37
1.5"	0.87	2.37	1.56	0.81
1.7"	0.87	2.57	1.60	0.97
2.0"	0.87	2.87	1.70	1.17
2. June (precipitation 3.59 inch/month)				
0"	0.84	0.84	0.75	0.09
1"	0.84	1.84	1.50	0.34
1.5"	0.84	2.34	1.58	0.76
1.7"	0.84	2.54	1.60	0.94
2.0"	0.84	2.84	1.61	1.23
3. July (precipitation 3.83 inch/month)				
0"	0.86	0.86	0.70	0.16
1"	0.86	1.86	1.50	0.36
1.5"	0.86	2.36	1.58	0.80
1.7"	0.86	2.56	1.60	0.96
2.0"	0.86	2.86	1.60	1.26

TABLE V-6 (Cont'd)

IRRIGATION(I) (in./week)	PRECIPITATION(P) (in./week)	I + P (in./week)	EVAPORATION(E) (in./week)	RECHARGE OR RUNOFF(R) (in./week)
4. August (precipitation 3.61 inch/month)				
0"	0.82	0.82	0.70	0.12
1"	0.82	1.82	1.50	0.32
1.5"	0.82	2.32	1.57	0.65
1.7"	0.82	2.52	1.60	0.92
2.0"	0.82	2.82	1.70	1.12
5. September (precipitation 3.02 inch/month)				
0"	0.71	0.71	0.55	0.16
1"	0.71	1.71	1.30	0.41
1.5"	0.71	2.21	1.55	0.66
1.7"	0.71	1.41	1.58	0.83
2.0"	0.71	2.71	1.60	1.11

Note: I + P = E + R

c. Because of the fragipan, the upper soil layer can generally be expected to behave as an evapotranspiration pond with water collecting in the 12 to 24 inches of soil that usually overlie the fragipan. The degree to which this volume is filled will determine whether runoff will occur during combined irrigation-precipitation.

With these points in mind, an application rate of 1.7 inches/week must be considered as an upper limit for the poorly drained upland soils. From Table V-6, this application rate would maintain the estimated recharge or runoff value below 1 inch/week. If the treated wastewater contains 20 mg/l N, 1.7 in/week over a 26-week period is equivalent to about 200 pounds N per acre per year. This is close to the requirements of many crops.

Excessive erosion can be controlled on the upland soils by using commonly accepted conservation practices such as diversion ditches, strip cropping, sodded waterways, and no application of effluent during prolonged rainy periods or freezing weather. Surface discharge and runoff can be reduced when lower application rates are used, and when effluent is applied in a staggered manner, (i.e., first using one area, then an adjacent area, before returning to the initial area). This procedure will allow more time for subsoil drainage between applications, and lateral groundwater movement will be reduced. This simple management procedure can be adopted for manually operated or automated systems. In all systems, management is the key to achieving a high degree of renovation over the long term, particularly with marginal sites.

SITE SELECTION IN BROOME & TIOGA COUNTIES

SOILS AND LAND USE

In selecting sites for the land application of sewage sludge and secondary effluent, several topographic, hydrologic, geologic, soil, and vegetation factors were considered. In particular, land slope, soil texture, soil permeability, depth to bedrock, annual precipitation, and evapotranspiration, and the type of vegetation cover were of primary concern. The slope of the terrain limits the possible thickness

of soil--the steeper the slope the thinner the soil. A very steep slope (greater than 15 percent) may not have enough soil for disposal or may have limited infiltration capacity.

An equally important consideration in selecting sites for land application of sewage sludge or secondary effluent was the land use pattern. Public concern requires that every effort be made to minimize any possible adverse effects on an area's social well being, economic structure, or environmental attributes.

From other studies, it was determined that location of largescale land application sites should meet the following criteria:

a. Lands which are ecologically unique should not be encroached upon.

b. Communities, public institutions, and commercial developments should be avoided.

c. The integrity of the transportation system within the area should be maintained. Road relocation and alterations would be avoided whenever possible.

d. The physical facilities (pipes, pumping stations, lagoons, etc.) should be located so as to cause a minimum of disruption to the farmer or the forester.

In Broome and Tioga Counties there are 12 major soil associations. The soil associations, the distribution of each of the soil series, the gradient, and the topographic location are displayed in Table V-7, while Figure V-7 depicts the areal distribution of soils by soil association. Due to the similarities between the Howard-Chenango associtation and the Chenango-Howard association, they are mapped as one unit in Figure V-7.

The soils of Broome and Tioga Counties generally can be categorized under two broad headings. The valley soils (combination of Chenango, Tioga, and Howard Soil Associations) are sufficiently level and well-drained to be suitable for land application. However, these soils overlie the major groundwater supplies for the region and water tables are close to the surface. Figure V-8 and Table V-8 indicate the types and locations and the principal aquifers in Broome and Tioga Counties. As is apparent, the principal aquifers which furnish much of the Urban Study Area's water supply are found in the major river valleys. The outlying valleys are the Bicounty Area's best agricultural lands, but they

TABLE V-7
SOIL ASSOCIATION CHARACTERISTICS *

SOIL ASSOCIATION	PRINCIPAL SERIES NAME	PRINCIPAL SERIES % OF ASSOC.	DOMINANT SLOPE GRADIENT	TOPOGRAPHIC LOCATION	SUSCEPTIBILITY TO EROSION
Volusia-Mardin	Volusia	45	5-15%	Steep	Moderate
	Mardin	30	5-25%	uplands	Moderate
	Lordstown	15	5-25%		Severe
	Chippewa	5	0-5%		Slight
	Other	5	Unclass.		Variable
Volusia-Lordstown	Volusia	40	5-15%	Uplands	Moderate
	Lordstown	35	0-25%		Severe
	Mardin	10	5-25%		Moderate
	Chippewa	5	0-5%		Slight
	Bath	5	0-15%		Moderate
	Others	5	0-15%		Variable
Volusia-Mardin-Lordstown	Volusia	50	5-15%	Level	Moderate
	Mardin	30	5-25%	uplands	Moderate
	Lordstown	15	5-25%		Severe
	Others	5	5-15%		Variable
Lordstown-Volusia	Lordstown	40	5-25%	Hilltops	Severe
	Volusia	30	5-15%	and	Moderate
	Mardin	20	5-25%	Uplands	Moderate
	Arnot	5	0-15%		Moderate
	Chippewa	5	0-5%		Slight

* See Figure V-7

TABLE V-7 (Cont'd)

SOIL ASSOCIATION	PRINCIPAL SERIES NAME	PRINCIPAL SERIES % OF ASSOC.	DOMINANT SLOPE GRADIENT	TOPOGRAPHIC LOCATION	SUSCEPTIBILITY TO EROSION
Lordstown-Volusia-	Lordstown	35	0-25%	High, steep	Severe
Mardin	Volusia	30	0-15%	uplands	Moderate
	Mardin	20	0-25%		Moderate
	Chippewa	5	0-15%		Slight
	Bath	5	0-15%		Moderate
	Others	5	0-15%		Variable
Chenango-Howard	Chenango)	65	0-15%		Slight
	Howard)			River valley	
	Unadilla	15	0-5%	terraces	Slight
	Canaderaga	10	5-15%		Moderate
	Middlebury	5	0-5%		Slight
	Wayland	5	0-5%		Slight
Howard-Chenango	Howard	35	0-8%	River valley	Slight
	Chenango	25	0-8%	terraces	Slight
	Tioga	15	0-3%		Slight
	Middlebury	10	0-3%		Slight
	Unadilla	5	0-8%		Slight
	Others	10	0-15%		Variable
Tioga-Chenango	Tioga	55	0-5%	River valley	Slight
	Chenango)	25	0-15%	Flood plains	Slight
	Howard)				
	Middlebury	10	0-5%		Slight
	Unadilla	5	0-5%		Slight
	Wayland	5	0-5%		Slight

TABLE V-7 (Cont'd)

SOIL ASSOCIATION	PRINCIPAL SERIES NAME	PRINCIPAL SERIES % OF ASSOC.	DOMINANT SLOPE GRADIENT	TOPOGRAPHIC LOCATION	SUSCEPTIBILITY TO EROSION
Howard-Langford	Howard	30	0-8%	River valleys	Slight
	Langford	25	0-15%	Lower uplands	Slight
	Valois	20	0-15%		Moderate
	Chenango	10	0-8%		Slight
	Others	20	0-15%		Variable
Middlebury-Chenango	Middlebury	45	0-3%	River valleys	Slight
	Chenango	25	0-8%		Slight
	Holly	10	0-3%		Slight
	Papakating	5	0-3%		Slight
	Others	5	0-5%		Variable
Canaseraga-Dalton	Canaseraga	55	5-15%	River valley walls	Moderate
	Dalton	30	5-15%		Slight
	Unadilla	5	0-5%		Slight
	Chenango) Howard)	5	0-15%		Slight
	Mardin-Volusia	5	5-25%		Moderate
Oquaga-Cattaraugus	Oquaga	30	15-25%	Rugged valley ridges and uplands	Moderate
	Cattaraugus	30	5-25%		Severe
	Morris	20	5-15%		Moderate
	Culvers	20	5-15%		Moderate

SOURCE: Egner & Niederkorn Associates, Inc., Southern Tier East Regional Planning Board Broome-Tioga Counties: Policy and General Plan

GENERAL SOIL ASSOCIATION MAP

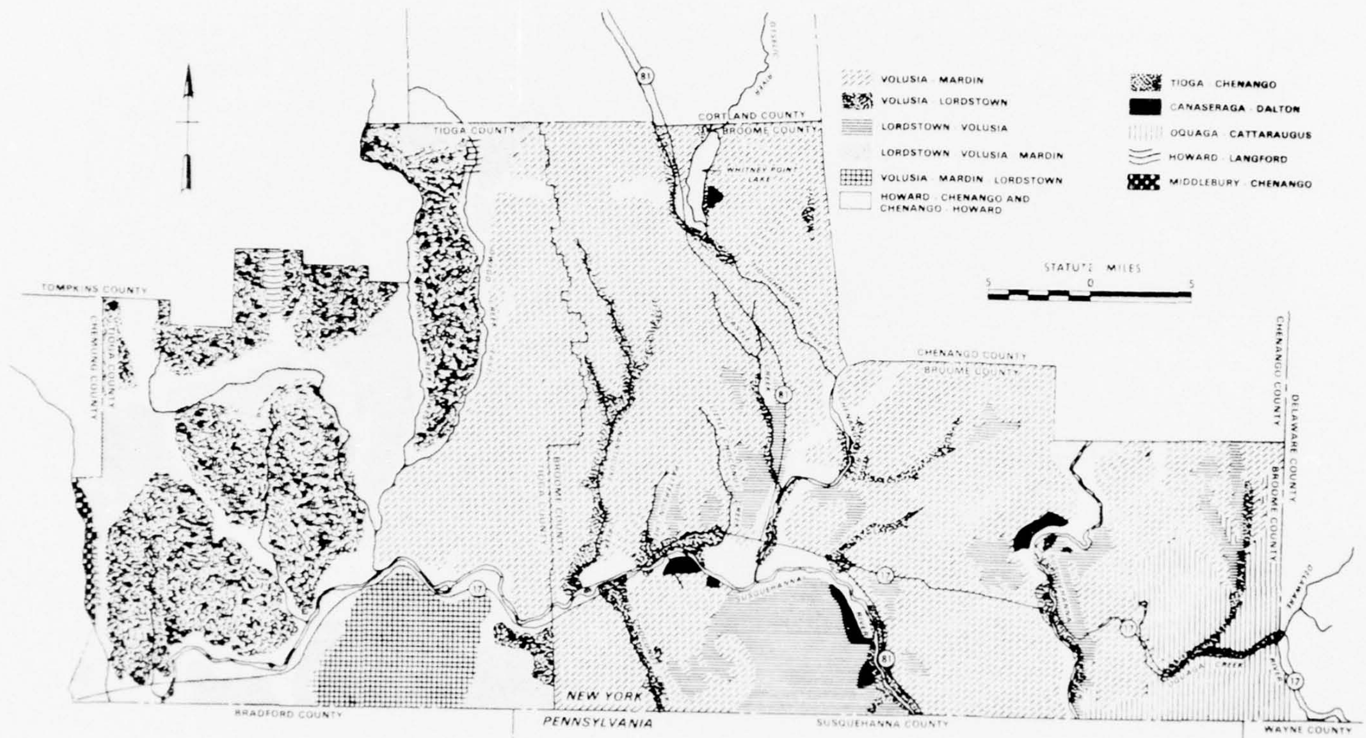


FIGURE V-7

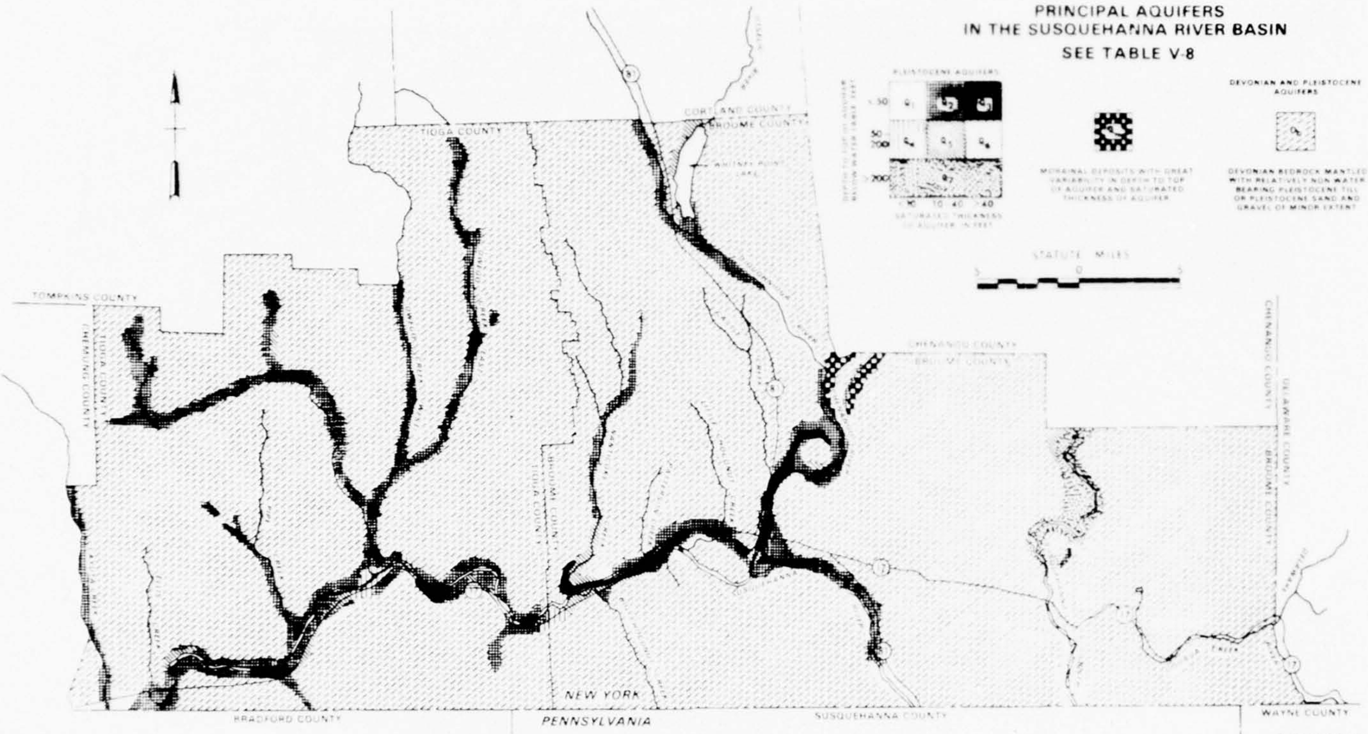

PRINCIPAL AQUIFERS
IN THE SUSQUEHANNA RIVER BASIN
SEE TABLE V-8
PLEISTOCENE AQUIFERS
DEVONIAN AND PLEISTOCENE AQUIFERS
MORAINAL DEPOSITS WITH GREAT VARIABILITY IN DEPTH TO TOP OF AQUIFER AND SATURATED THICKNESS OF AQUIFER
DEVONIAN BEDROCK MANTLED WITH RELATIVELY NON-WATER BEARING PLEISTOCENE TILL OR PLEISTOCENE SAND AND GRAVEL OF MINOR EXTENT
SATURATED THICKNESS OF AQUIFER IN FEET
STATUTE MILES
TOMPKINS COUNTY
TIOGA COUNTY
CHEMUNG COUNTY
CORTLAND COUNTY
BROOME COUNTY
CHENANGO COUNTY
DELAWARE COUNTY
WAYNE COUNTY
BRADFORD COUNTY
SUSQUEHANNA COUNTY
NEW YORK
PENNSYLVANIA

FIGURE V-8

TABLE V-8

GENERALIZED STRATIGRAPHIC COLUMN AND HYPOTHETICAL
WELL YIELDS OF AQUIFERS
(See Figure V-8)

GEOLOGIC AGE	AQUIFER	SYMBOL ON FIGURE V-8	DEPTH (FEET)	THICKNESS (FEET)	WELL YIELD (gpm)[1] POOR	MEDIUM	GOOD
Pleistocene	Outwash	Q_1	50	<10	66	180	500
Pleistocene	Outwash	Q_2	50	10-40	550	1100	2400
Pleistocene	Outwash	Q_3	50	>40	1500	3700	9000
Pleistocene	Outwash	Q_4	50-200	<10	120	550	3000
Pleistocene	Outwash	Q_5	50-200	10-40	520	1300	3300
Pleistocene	Outwash	Q_6	50-200	>40	1200	1900	2900
Pleistocene	Outwash		200	-	110	600	3700
Pleistocene	Lacustrine Deposits	Q_7	Entire Section	-	32	98	320
Pleistocene	Morainal Deposits	Q_m	Entire Section	-	84	260	840
Devonian	Bedrock	D_b	0-200	-	29	60	130

[1]Hypothetical drilled well yields based on certain well design criteria and estimated aquifer specific capacity as stated in reference source.

Source: Hollyday, Este F., An Appraisal of the Ground-Water Resources of the Susquehanna River Basin in New York State.

also overlie the principal aquifers where the risk of water supply contamination and stream degradation is significant.

Figure V-9 shows a general land use map for the Bicounty Area. The figure indicates that most residential, commercial, and industrial areas are in the river valleys as well as the prime agricultural lands in the outlying valleys. These facts, considered in light of the principal aquifers which are also found in the river valleys, made the valley soils appear unattractive for land application.

Most of the Bicounty Area, however, is covered by upland soils of the Lordstown, Mardin, and Volusia Associations (see Figure V-7). These soils are moderately to steeply sloped, shallow, and poorly drained due to a dense soil layer or fragipan close to the ground surface. The water table is within several feet of the surface for much of the year. Residential development is sparse and the groundwater has limited water supply use (Figures V-8 and V-9). Although the poor drainage, hilly nature and high water table of the upland soils are not ideal for land application, they are in fact, the only soils in the Bicounty Area for which land application can be considered feasible.

SPECIFIC SITE RECOMMENDATIONS

The upland soils were investigated to determine acceptable sites, either for land application of sludge or secondary effluent. Feasible slopes were considered to be 0 to 8 percent and 8 to 15 percent. Areas in proximity to rivers, creeks, gullies, drainage channels, and eroded slopes were avoided to prevent potential surface water contamination. Fractured rocks, gravels, and shallow water tables were avoided to prevent potential groundwater contamination.

Site visits, topographic maps, soil survey maps, and land use plans were the sources of necessary information. Soil types and thickness, drainage characteristics, erodibility, water holding capacity, and demographic characteristics were investigated. Generally, three soil associations were found to meet the general requirements for land application; these three associations were Volusia-Mardin, Lordstown-Volusia-Mardin, and Mardin-Volusia.

Six areas (three sites in Broome and three sites in Tioga) were identified as possessing acceptable characteristics for land application within an economically feasible transport

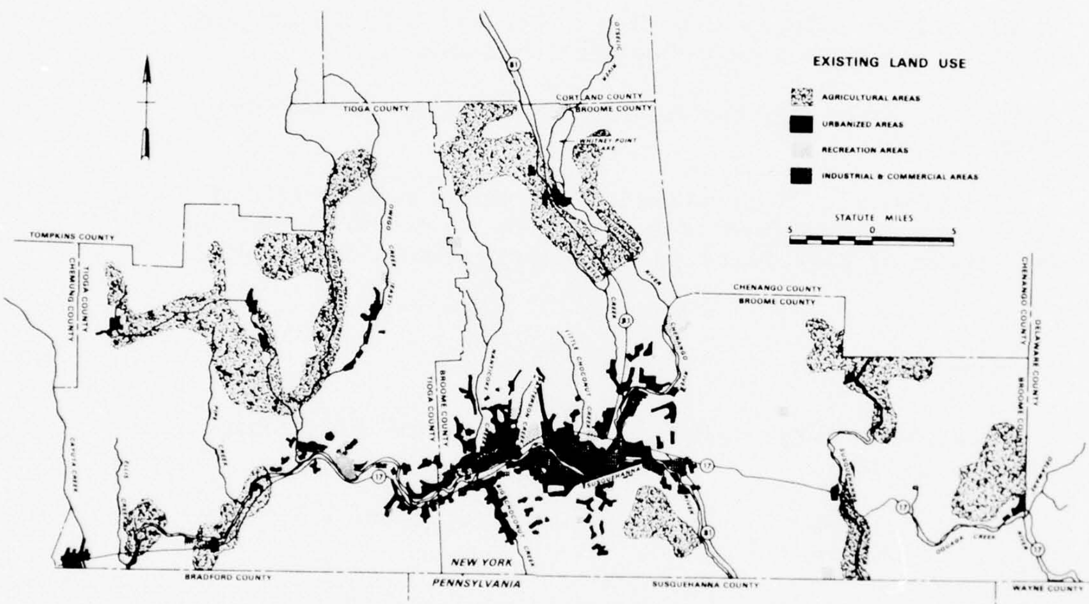

EXISTING LAND USE
AGRICULTURAL AREAS
URBANIZED AREAS
RECREATION AREAS
INDUSTRIAL & COMMERCIAL AREAS
STATUTE MILES
5 0 5
TIOGA COUNTY
CORTLAND COUNTY
BROOME COUNTY
TOMPKINS COUNTY
TIOGA COUNTY
CHEMUNG COUNTY
CHENANGO COUNTY
BROOME COUNTY
CHENANGO COUNTY
DELAWARE COUNTY
BROOME COUNTY
TIOGA COUNTY
BROOME COUNTY
SUSQUEHANNA
NEW YORK
PENNSYLVANIA
BRADFORD COUNTY
SUSQUEHANNA COUNTY
WAYNE COUNTY

FIGURE V-9

distance from the Urban Study Area. The six areas are outlined on Figure V-10, and are briefly described in the following paragraphs.

Site No. 1

Location: The Osborne Creek Area in the Town of Fenton in Broome County.

Area: 12 square miles (7,680 acres), about 7.1 square miles suitable (4,550 acres).

Scil Association: Volusia-Mardin

Suitability: Slopes 0 to 8 percent and 8 to 15 percent (slight to moderate); very few populated areas.

Current Use: pastures, native forests, plowed land, orchards.

Limitations: High hazard of erosion and runoff will exist when the surface of the soil is bare and during the wet season if high rates of secondary effluent are applied.

Site No. 2

Location: Binghamton Area--South from Binghamton, Broome County.

Area: 12 square miles (7,680 acres), about 7.1 square miles suitable (4,550 acres).

Soil Associations: Lordstown-Volusia-Mardin

Suitability: Slopes 0 to 8 percent and 8 to 15 percent (slight to moderate); shorter distance from Binghamton than Site No. 1.

Current Use: native forests, pastures, plowed land, orchards.

Limitations: moderately populated area.

Site No. 3

Location: West and East from Castle Creek in Chenango Area, Broome County.

Area: 7.1 square miles (4,550 acres), about 2.2 square miles suitable (1,400 acres).

Soil Associations: Volusia-Mardin.

Suitability: Slopes 0 to 8 percent; short distance from Binghamton, good major roads for transportation of sewage sludge by trucks.

Current Use: pastures, forest, plowed land.

Limitations: Western portion relative high percentage forest, low percent plowed land and in some locations slopes over 8 percent; relatively poor secondary roads, and high population compared to eastern portion of Site No. 3.

Site No. 4

Location: The Little Nanticoke Creek in the Owego Area, Tioga County.

Area: 1.5 square miles (950 acres), about 1.4 square miles suitable (900 acres).

Soil Associations: Volusia-Mardin

Suitability: Slopes 0 to 8 percent for liquid sewage sludge; slopes 0 to 8 percent and 8 to 15 percent for wastewater; good roads; short distance from Owego STP #1, Owego STP #2, and Owego Village STP; very few populated areas.

Current Use: pastures, plowed land, native forest.

Site No. 5A

Location: South Central Owego, Tioga County.

Area: 1.5 square miles (950 acres), mostly suitable.

Soil Associations: Mardin-Volusia

Suitability: Short distance from Owego STP #1, and Owego Village STP; good roads; slopes 0 to 8 percent and 8 to 15 percent (slight to moderate).

Current Use: native forest, pastures, plowed land.

Limitations: moderately populated area surrounding site.

Site No. 5B

Location: South Central Owego, Tioga County

Area: 1.0 square mile (640 acres), about 0.8 square mile suitable (500 acres).

Soil Associations: Volusia-Mardin

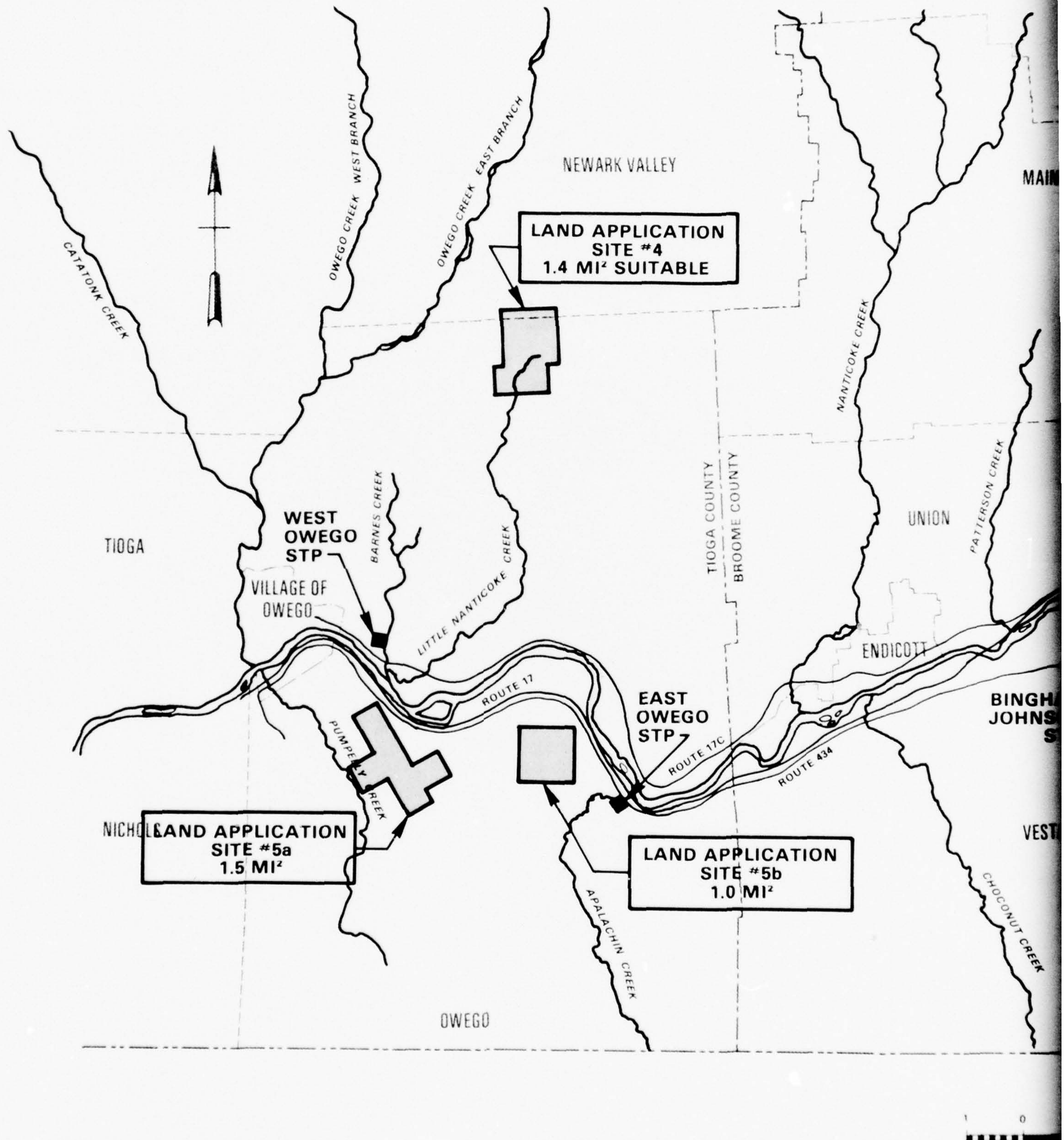
Suitability: short distance from Owego STP #2, good roads, slopes 0 to 8 percent and 8 to 15 percent (slight to moderate).

Current Use: plowed land, pasture, native forest.

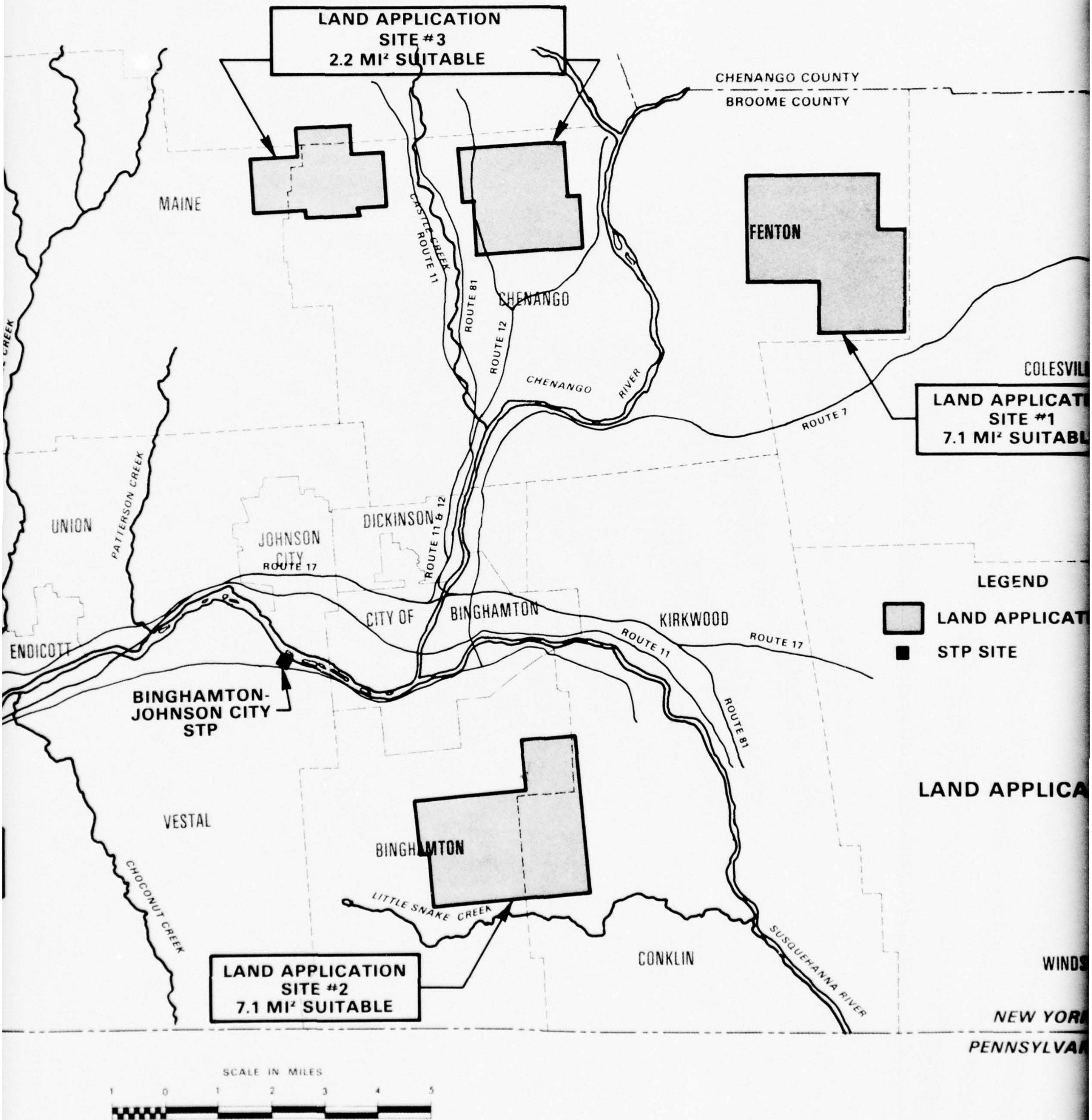
Limitations: moderately populated area adjacent to site.

DESCRIPTIONS OF SOIL UNITS AT RECOMMENDED SITES

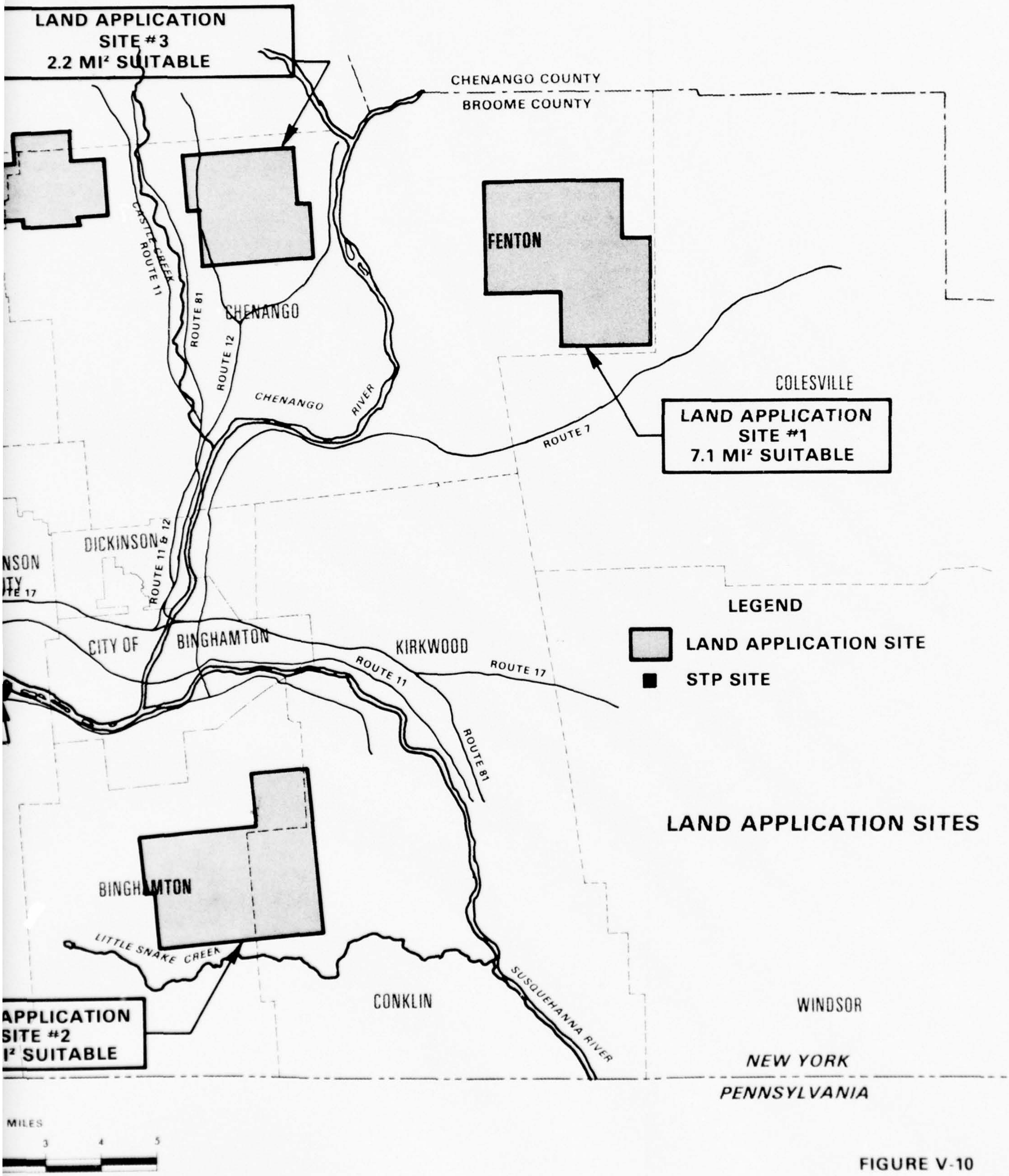
Although the recommended sites are generally located on the upland soil associations of Volusia-Mardin, Lordstown-Volusia-Mardin, or Mardin-Volusia, differences in the soil units making up the various soil associations are important. Susceptability to erosion, cropping practices, physical-chemical properties, wet and dry characteristics, and many other factors combine to make each soil unit a separate entity. Therefore, within each block of land identified as one of the recommended sites, local variances of the soil units may make one portion better than another for land application. Soil units at the recommended sites are discussed in the following paragraphs.



NEWARK VALLEY
LAND APPLICATION SITE #4 1.4 MI² SUITABLE
CATATONK CREEK
OWEGO CREEK WEST BRANCH
OWEGO CREEK EAST BRANCH
MAIN
TIOGA
WEST OWEGO STP
BARNES CREEK
LITTLE NANTICOKE CREEK
VILLAGE OF OWEGO
TIOGA COUNTY
BROOME COUNTY
NANTICOKE CREEK
UNION
PATTERSON CREEK
ENDICOTT
ROUTE 17
EAST OWEGO STP
ROUTE 17C
ROUTE 434
PUMPELLY CREEK
NICHOLS
LAND APPLICATION SITE #5a 1.5 MI²
LAND APPLICATION SITE #5b 1.0 MI²
APALACHIN CREEK
CHOCONUT CREEK
VEST
BINGHA
JOHNS
OWEGO
1
0



LAND APPLICATION
SITE #3
2.2 MI² SUITABLE
CHENANGO COUNTY
BROOME COUNTY
MAINE
FENTON
CASTLE CREEK
ROUTE 11
ROUTE 81
ROUTE 12
CHENANGO
CHENANGO
RIVER
COLESVILL
LAND APPLICAT
SITE #1
7.1 MI² SUITABL
ROUTE 7
CREEK
PATTERSON CREEK
UNION
JOHNSON
CITY
DICKINSON
ROUTE 11 & 12
ROUTE 17
LEGEND
LAND APPLICAT
STP SITE
CITY OF
BINGHAMTON
KIRKWOOD
ENDICOTT
ROUTE 11
ROUTE 17
BINGHAMTON-
JOHNSON CITY
STP
ROUTE 81
LAND APPLICA
VESTAL
BINGHAMTON
CHOCONUT CREEK
LITTLE SNAKE CREEK
CONKLIN
SUSQUEHANNA RIVER
WINDS
LAND APPLICATION
SITE #2
7.1 MI² SUITABLE
NEW YOR
PENNSYLVA
SCALE IN MILES
1 0 1 2 3 4 5



LAND APPLICATION SITES

FIGURE V-10

3

VoA -- Volusia Channery Silt Loam,
0 to 3 percent slopes.

It is a deep, gently sloping, somewhat poorly drained soil with a well-expressed fragipan. The root zone, only 15 to 18 inches thick over the fragipan, is capable of supplying only a small amount of moisture. Reaction is strongly acid, and the capacity to supply both potassium and phosphorus is medium. Wetness is the main limitation. Erosion is a hazard. These soils can be cultivated, but must be managed carefully. Diversion terraces and contour farming help to improve drainage and control erosion. If these measures are not used, sod crops and legumes are tolerant of wetness and are more dependable than row crops. Both lime and fertilizer are needed.

VoB -- Volusia Channery Silt Loam,
3 to 8 percent slopes.

This unit consists of loamy soils of the Mardin and Volusia series. These are deep, moderately sloping, somewhat poorly drained soils with a well-expressed fragipan. The root zone, only 12 to 18 inches thick, is capable of supplying only a small amount of moisture. Reaction is strongly acid, and the capacity to supply both potassium and phosphorus is medium. Runoff is rapid and erosion is a hazard.

Overcoming extremes of wetness and dryness are problems. These soils are suited to many of the crops grown in the Bicounty Area, but are better suited to sod crops than to row crops. The slope and the shallowness to the fragipan result in wetness early in spring and dryness in summer. Diversion ditches help to remove the excess water and permit early cultivation and plant growth. A more serious problem is overcoming lack of moisture in summer. Contour farming, minimum tillage, and the use of sod crops help to keep the soils open. Moisture stored in winter encourages early growth of sod crops, and if the soils are well fertilized and limed, the yields of first cuttings are increased.

VoC -- Volusia Channery Silt Loam,
8 to 15 percent slopes.

It is a deep, somewhat poorly drained soil with a well-expressed fragipan. The root zone, only 8 to 10 inches thick, is capable of supplying only a small amount of moisture. Reaction is strongly acid, the capacity to supply potassium is medium, and the capacity to supply phosphorus is low. The hazard of further erosion is severe. Erosion has thinned the surface layer and has depleted the natural organic matter content. Wetness is a limitation in spring, and droughtiness in summer. Cultivated crops can be grown in small areas that are within fields containing other soils that are cultivated, but these areas need to have organic matter added and fertility improved. Sod crops generally are more dependable than cultivated crops. Large amounts of lime and fertilizer are needed for whatever crop is grown.

LdC -- Lordstown Channery Silt Loam,
5 to 15 percent slopes.

This soil is deep to moderately deep, moderately sloping and well drained. Either a well-expressed fragipan or bedrock restricts the root zone to the topmost 20 to 40 inches. The root zone is capable of supplying a moderate to large amount of moisture. Reaction is strongly acid, and the capacity to supply both potassium and phosphorus is medium. Runoff and erosion are hazards and may restrict use for crops in the more sloping areas. These soils are suited to all crops commonly grown in Broome County, but they may be short of moisture in summer. Early cultivation is possible, and a high level of management is justified. Measures that reduce runoff and conserve soil and moisture are needed. Among these are contour farming, strip-cropping, minimum tillage, and crop-residue management. Full stands of deep-rooted crop help to protect the soils. Sod crops should be made part of the cropping system. Diversion ditches are needed in many places, but their construction could be limited by the depth to bedrock. Deep placement of lime encourages deeper root growth. Fertilizer is needed for all crops.

Mmb -- Mardin Channery Silt Loam, 0 to 8 percent slopes.

MhC -- Mardin Channery Silt Loam, 5 to 15 percent slopes.

Mhb -- Mardin Channery Silt Loam, 2 to 8 percent slopes.

These soils are deep, moderately sloping, moderately well drained or well drained. The root zone, only 18 to 24 inches thick over the fragipan, is capable of supplying only a moderate mount of moisture. Reaction is strongly acid, and the capacity to supply both potassium and phosphorus is medium. Erosion is a hazard. These soils are suited to all crops grown in the county. Slope and the thinness of root zone are limitations. Needed are measures that safely remove excess surface water. Dryness in midsummer and the hazard of erosion are limitations for farm use. Under a high level of management, such measures consist of strip-cropping, diversion ditches, minimum tillage, contour farming, crop-residue management, and the use of sod crops in the cropping system. Deep placement of lime encourages deeper root growth. Fertilizer should be added in amounts adequate for the crop grown. This soil is suited to crops, pasture plants, hay, and forest.

AcA -- Alden and Chippewa Soil,
0 to 3 percent slopes.

CpB -- Chippewa Channery Silt Loam,
3 to 8 percent slopes.

These units consist of loamy soils of the Alden and Chippewa series. They are deep, nearly level and gently sloping, poorly drained, and very poorly drained soils on uplands. Chippewa soils have a fragipan. Their root zone is only 10 to 18 inches thick, but plants are rarely affected by lack of moisture. Reaction is strongly acid to slightly acid, and the capacity to supply both potassium and phosphorus is medium. Wetness is the main limitation. These soils are suited to cultivated crops only if they are drained. Control of surface water is needed to protect the gently sloping soils from erosion. If cultivated crops are grown, they should be planted on the contour and sod waterways and surface drains should be provided for safe; quick removal of surface water also permits management for selected sod crops that tolerate wetness. Both lime and fertilizer are needed for all crops. The sod crops benefit from nitrogen fertilizer.

Ta -- Tioga Silt Loam.

It is a deep, nearly level, well-drained soil on flood plains. The root zone, 40 inches or more thick, is capable of supplying a large amount of moisture. Reaction is moderately acid, and the capacity to supply both potassium and phosphorus is medium. Flooding generally is not a hazard during the growing season. This soil is well suited to all the crops grown here. There are few restrictions to intensive cultivation if the soil is limed and fertilized according to crop needs.

Wd -- Wayland Silt Loam.

It is a deep, nearly level, poorly drained, and somewhat poorly drained soil of flood plains. Undrained, the root zone is only about 12 inches thick over the water table, and plants do not lack moisture. Reaction is variable, and the capacity to supply both potassium and phosphorus is medium. Wetness and flooding are the main limitations. This soil is suited to cultivated crops only if it is drained and protected from flooding during the growing season. It should not be worked when wet. Sod crops that are tolerant of wetness show good response to high-nitrogen fertilizer. Lime should be added in amounts determined by soil tests.

Table V-9 summarizes the important characteristics of the soil units found at Sites 1, 2, and 3 in Broome County.

Tioga County -- Sites 4, 5A, and 5B

Fvg -- Fremont and Volusia Channery Silt Loams,
0 to 8 percent slopes.

This unit is on smooth, somewhat poorly drained areas at high elevations. The soil profile and parent material are strongly to very strongly acid. The substratum is slowly permeable to moisture and air and not easily penetrated by roots. The upper soil layers are wet until late in spring, but in dry years they become very hard and dry and the surface of the soil cracks. These extremes of moisture conditions and the accompanying extremes in aeration result in

TABLE V-9

SOIL UNITS--SUMMARY OF IMPORTANT CHARACTERISTICS, BROOME COUNTY (LAND APPLICATION SITES 1, 2, and 3)

Map Symbol	Soil	Topsoil	Slope	Depth to Bedrock	Depth to Seasonal High Water Table	Depth From Surface	Permeability In Per Hour	Available Moisture Capacity	Agricultural Drainage	Irrigation	Remarks
VoB	Volusia channery silt loam	Poor	3-8	4+ ft	1/2-1 ft	0-17 in	0.63-2.0 (slight)	0.17-0.21 in per inch of soil	Slow permeability in fragipan at depth of 15 to 18 inches.	Moderate water intake rate; moderate to low available moisture capacity; root zone 15 to 18 inches thick (severe)	Highly variable content of stones larger than 3 inches in size.
VoA	Volusia channery silt loam		0-3								
VoC	Volusia channery silt		8-15								
LdC	Lordstown channery silt loam	Poor, contains rock fragments	5-15	2-3 1/2 ft	2-3 1/2+ft	0-28 in channery silt loam; 28 in sandstone or shale bedrock	0.63-2.0 (slight)	0.17-0.20 in per inch soil	Generally not needed, 20 to 40 inches thick over bedrock	Moderate water intake rate; moderate to high available moisture capacity	Highly variable content of stones larger than 3 inches in size; water table occasionally perched on bedrock
MhC Mhb	Mardin Channery silt loam	Poor contains rock fragments	8-15 2-8	5+ ft	1 1/2-2 ft (moderate)	0-18 in channery silt loam; 18-70 in dense channery silt loam to very channery silt loam fragipan	0.63-2.0 (slight)	0.17-0.20 in per inch of soil	Slow permeability in fragipan at depth of 18 to 22 inches; seasonally high water to be at depth of 1 1/2 to 2 feet	Moderate water intake rate; moderate available moisture capacity; root zone 18 to 24 inches thick (severe-moderate)	Highly variable content of stones larger than 3 inches in size
Mnb	Mardin Channery silt loam	Poor, contains rock fragments	0-8	5+ ft	1 1/2-2 ft	0-18 in channery silt loam; 18-70 dense channery silt loam to very channery silt loam fragipan	0.63-2.0 (slight)	0.17-0.20 in per inch of soil	Bedrock at depth of 20 to 40 in slow permeability in fragipan at depth of 18 to 22 inches. Seasonal high water table at depth of 1 1/2 to 2 feet.	Moderate water intake rate; moderate available moisture capacity; root zone 18 to 22 inches thick.	Highly variable content of stones larger than 3 inches in size. Soil is underlain by sandstone or shale bedrock at a depth of 20 to 40 inches
CpB	Chippewa Channery silt loam	Poor, contains rock fragments	3-8	4+ ft	0-1 ft	0-12 channery silt loam; 12-48 dense channery silt loam fragipan and substratum	0.2-2.0 (slight)	0.20-0.23 in per inch of soil	Slow permeability at depth of 10 to 18 inches	Moderate water intake rate; moderate available moisture capacity; limited root zone	Highly variable content of stones larger than 3 inches in size
AcA	Alden and Chippewa soil	Fair; wet in natural state	0-3	4+ ft	0 ft	0-10 in silt loam, 10-20 silty clay loam, 20-36 in dense silt loam silt	0.20-2.0 (slight)	0.17-0.25 in per inch of soil	High water table; cut slopes may be subject to piping and sloughing; natural outlets may be inadequate.	Not applicable.	Highly variable content of stones larger than 3 inches in size in substratum
Ta	Tioga silt loam	Poor; contains rock fragments	0	5+ ft	>2 ft	0.35 in silt loam and very fine sandy loam; 35-70 gravelly and sandy or sandy strata	0.63-6.3	0.16-0.20	Not generally needed	Occassional flooding; moderate to high water intake rate; variable available moisture capacity, variable root zone thickness	Occasionally flooding.
Wd	Wayland silt loam		0	5+ ft	0-1/2 ft	0-40 in silt loam; 40-45 in stratified silt loam fine sandy loam, and sandy loam	0.20-2.0 (slight)	0.16-0.19	Flooding, outlets inadequate	Not applicable	Subject to flooding. The material below a depth of 40 inches is variable.

low crop yields. The land is probably best kept in permanent meadow for hay or pasture, but a grain followed by long-term hay or a rotation of corn, grain, and long-term hay can be used where the grains are needed on the farm and where areas of better drained soils are not available for production of these crops. Tile drainage is not economically feasible on most areas of these soils, but properly designed diversion terraces can be used to improve moisture conditions in many places. Strip cropping may be necessary to prevent serious erosion on the steeper slopes.

Mcu -- Mardin Channery Silt Loam, Undulating Phase,
0 to 8 percent slopes

This unit is found in small to medium sized areas on smooth ridge tops or benchlike positions in the higher uplands and is associated with other Mardin soils and members of the Volusia and Lordstown series. The upper 15 to 18 inches of the profile are well-aerated and permeable to roots and moisture most of the year, but the lower subsoil and hardpan are waterlogged in fall, winter, and early in spring. The hardpan restricts free water movement, so that the soil is characterized by extremes of moisture conditions. It is saturated near the surface during much of fall and spring and is very dry in the drier summer months. The smooth even slopes of low gradient are favorable for crops, but the impeded drainage, strong acidity, and low natural fertility of this soil limit to some extent the kind of crops that can be grown.

Vcl -- Volusia Channery Silt Loam,
0 to 8 percent slopes.

It is by far the most extensive upland soil unit found on gentle slopes. The soils were formed under hardwood forests of maple, oak, some hickory, beech, and some other small trees. The profile and parent material are strongly acid throughout. Moisture and air circulate poorly in the soil, and roots of most crop plants do not penetrate the hardpan.

The soil is characterized by extremes of moisture conditions. It warms and dries very slowly in spring but may become very dry and hard late in summer. While the soil is wet in spring, roots are confined to shallow depths; thus, when the soil becomes dry in summer, the roots can draw

moisture from only a small volume of soil. About 35 percent of the total area is cropland, 25 percent is in pasture; 25 percent is woodland, and 15 percent is idle land or wasteland. For good yields of corn and grain, manure, phosphate, and some additional potash are needed. Lime and phosphorus are essential for success with grass and good response will be obtained if top dressing of sewage sludge or wastewater is applied to new seedings or to older stands of grass hay.

Cc -- Chippewa Channery Silt Loam,
0 to 8 percent slopes.

This very poorly drained gray acid soil is mainly in many widely separated areas in the uplands, generally in long narrow strips in depressed places or along intermittent drainageways. The soil and parent material are acid. The entire profile is saturated with moisture most of the year, and as a result, aeration is poor and root growth is inhibited. Slightly more than 25 percent is in forest and 55 percent is in pasture. Most of the rest is idle or wasteland, but a few better drained areas are in hay. Because of its very poor drainage, strong acidity, and low inherent fertility, pasture is the most intensive use to which this soil is suited. Reed canary grass, a grass well suited to poor drainage, may be fairly well suited to this soil if the fertility level is raised. The supplies of lime, nitrogen, and phosphorus are low.

Acl -- Allis Channery Silt Loam,
3 to 8 percent slopes.

It is a poorly drained, medium textured, strongly acid soil, 12 to 20 inches thick over bedrock. It is best suited to hay and pasture. Drainage might be improved by building diversion terraces on the deeper areas of this soil. On pastures, heavy applications of phosphorus and lime are needed for good production.

Lcl -- Lordstown Channery Silt Loam, Gently Sloping Phase
0 to 5 percent slopes.

This phase occupies the relatively narrow, gently sloping crests of higher ridges in the uplands. It has properties of

workability and conservability superior to most other soils of the higher uplands and is a relatively important agricultural soil. Contour tillage, as a soil and water conservation measure, is a good practice on this soil wherever feasible.

Mcs -- Mardin Channery Silt Loam, Eroded Sloping Phase
9 to 15 percent slopes.

Mcp -- Mardin Channery Silt Loam, Eroded Sloping Phase
9 to 15 percent slopes.

As on other Mardin soils, the entire profile is strongly acid. Permeability to roots and water is less favorable than on the sloping phase, and the supplies of moisture for plant growth are less favorable because of the shallow depth to the compact substratum. About half of it is in cropland, and the rest is about equally divided between idle land and pasture. A few small areas are wooded. This eroded soil is probably best suited to long-term hay or to grain-hay rotations.

Lcs -- Lordstown Channery Silt Loam, Sloping Phase,
6 to 15 percent slopes.

This well-drained relatively shallow acid soil occurs in medium to large irregularly shaped areas throughout the higher uplands of the county. It is low in natural productivity, but because of its large acreage, it a moderately important agricultural soil. About 40 percent of the soil is in forest, slightly more than one-fourth is in cropland, and the rest is about evenly divided between pasture and idle land. Contour tillage is a soil and water-conserving practice needed on this soil, and on most areas additional supporting practices, including use of diversion terraces and strip cropping, are also needed. In addition to regular application of fertilizers, permanent pastures need occasional clipping for weed control.

Vcs -- Volusia Channery and Gravelly Silt Loams, Sloping
Phases, 9 to 15 percent slopes.

These poorly drained, acid soils, most extensive of any in Tioga County, occupy more than 16 percent of the total area. In spite of their large acreage, they are of only moderate

agricultural importance because of limited use suitability. Proper utilization of these soils is one of the more serious problems in land use in the county. More rapid surface drainage permits the soils to warm and dry earlier in spring and thus increases slightly the effective growing season, and especially the timeliness of spring work. Diversion terraces to improve drainage and retard erosion, contour tillage, and strip cropping are needed on all areas where row crops are grown in rotation. The improvement of aeration and moisture conditions, is one of the more essential requirements of good management for this and other Volusia soils. About 30 percent is cropland; 30 percent forest; 25 percent pasture; and 15 percent idle.

Bcs -- Bath Channery Silt Loam, Sloping Phase,
6 to 15 percent slopes.

The soil is strongly to very strongly acid throughout. It is easily permeable to air, roots, and moisture; but the medium texture retains sufficient moisture for plants. In forested areas, the surface of the soil is covered with 1 to 2 inches of leaves, twigs, and other plant debris. The workability, favorable moisture content, and smooth slopes of Bath Channery silt loam, sloping phase, make it suitable for a large number of crops, but strong acidity and low natural fertility make it somewhat exacting in management requirements. Slightly more than half of the soil is in crops; about 40 percent is in woodland; and the remaining small areas are idle or in pasture. Mixed hay, small grain, potatoes, and corn are the important crops. Contour tillage should be practiced where feasible to conserve moisture and soil material, and strip cropping may be necessary on the longer, more sloping fields. Pastures can be maintained at a high level of fertility by application of limestone and fertilizers.

Cdr -- Canfield Gravelly Silt Loam, Rolling Phase,
9 to 16 percent slopes

This is the most extensive member of the Canfield series and one of the more important agricultural soils of the uplands. The surface layer is fairly well supplied with organic matter; the entire soil profile and parent material are strongly acid; and the hardpan layer impedes water and air

movement. The soils are characterized by extremes of moisture conditions: it remains too wet for normal tillage until moderately late spring and becomes very dry in the upper layers in the drier summer months. About 50 percent of the land is in crops, 20 percent in pastures, and 10 percent is idle. The rest is in forest. This soil has moderately favorable slopes and is moderately easy to maintain in good tilth; but its impeded drainage, low natural fertility, and strong acidity make it somewhat exacting in management requirements and limit its use to some extent. Rotations (including row crops, contour tillage, strip c opping, and diversion terraces, alone or in some combination) are necessary to conserve soil material and maintain moisture content for crop growth.

Table V-10 summarizes the important characteristics of the soil units found at Sites 4, 5A, and 5B in Tioga County.

SUMMARY

Chapter V has discussed the potential for land application of both liquid sludge and secondary effluent at recommended sites in the Bicounty Area. Soils, geology, hydrology, topography, climate, and other factors were considered in determining acceptable application techniques, seasons, and rates. Since valley soils were found near metropolitan areas, adjacent to surface waters, and over major aquifers, the upland soils were investigated as having better potential for land application.

Six sites were located that possess the necessary features for land application, either for secondary effluent or sludge, within a reasonable transport distance from the Urban Study Area. A summary of the results for the land application study are presented in Table V-11.

TABLE V-10

SOIL UNITS: SUMMARY OF IMPORTANT CHARACTERISTICS
TIOGA COUNTY (LAND APPLICATION SITES 4, 5A, & 5B)

MAP SYMBOL	TOPO-GRAPHIC POSITION	SLOPE	SOIL	SURFACE SOIL	SUBSOIL	HARDPAN	PARENT MATERIAL	DEPTH	DRAIN-AGE	EROSION	NATURAL FERTIL-ITY	WORK ABIL-ITY	PRESENT USE
Fvg	Uplands	0-8	Fremont & Volusia Channery silt loams gently sloping phases	Acid channery silt loam about 6 inches thick	moderately friable acid silt loam 12 -18 inches thick	Weakly expressed pale-gray compact acid channery silt loam 12-14 inches thick	glacial till of olive-gray compact acid channery silt loam bedrock at 4 to 10 ft.	moderately deep	poor	low	low	fair	Forest, idle, hay pasture
Mcu	Uplands	0-8	Undulating phase	Mordin channery acid silt loam 6 to 8 inches thick	channery acid silt loam 12 to 16 inches thick, mottled before 15 inches	Strongly expressed light-gray to olive compact channery acid silt loam 10 to 18 inches thick	glacial till of compact olive to gray channery acid silt loam, bedrock at 4 to 10 ft.	moderately deep	moderately deep	low	low	good	Hay, small grains, forest, pasture, idle
Vol	Uplands	0-8	gently sloping phases	Volusia channery acid silt loam 4 to 8 inches thick	firm acid silt loam 8-15 in. thick	channery acid compact silt loam 10-15 inches thick	compact acid gravelly or channery silt loam	moderately deep	poor	low	low	poor	Hay, pasture forest, idle small grains

TABLE V-10 (Cont'd)

MAP SYMBOL	TOPO-GRAPHIC POSITION	SLOPE	SOIL	SURFACE SOIL	SUBSOIL	HARDPAN	PARENT MATERIAL	DEPTH	DRAIN-AGE	EROSION	NATURAL FERTIL-ITY	WORK ABIL-ITY	PRESENT USE
Cc	Uplands	0-8	Chippewa channery silt loam	acid gravelly silt loam high in org. matter 4 to 8 in. thick	acid gravelly silt loam, 18 to 24 inches thick		cannery compact acid silt loam; bed-rock at 4 to 10 ft.	moder-ately deep	very poor	very low	low	poor	Pasture, forest, idle
Acl	Uplands	3-8	Ollis channery silt loam gently sloping phase	strongly acid silt loam 6 to 8 inches thick	silt loam strongly acid 4 to 6 inches thick	very dense compact silt loam to silty clay loam 10 to 15 in. thick	acid silt loam-bedrock at 30 in. or less	shallow	poor	moder-ately	very low	fair	Pasture, hay, forest
Lcl	Uplands	0-5	gently sloping phase	Lordstown acid channery silt loam 6 to 8 in. thick	acid chan-nery silt loam 12 to 16 in. thick	None	compact acid stony silt loam; bedrock generally at about 3 feet	shallow	good	low	low	good	Forest, hay grains, idle pasture

TABLE V-10 (Cont'd)

MAP SYMBOL	TOPO-GRAPHIC POSITION	SLOPE	SOIL	SURFACE SOIL	SUBSOIL	HARDPAN	PARENT MATERIAL	DEPTH	DRAIN-AGE	EROSION	NATURAL FERTIL-ITY	WORK ABIL-ITY	PRESENT USE
Mcs Mcp	Upland	9-15	Sloping phase	Mordin channery acid silt loam 6 8 inches thick	channery acid silt loam 12 to 16 in. thick; mottled be-low 15 in.	compact channery silt acid silt loam 10 to 18 in. thick	channery acid silt loam; bed-rock at 4 to 10 ft.	moder-ately deep	moder-ately good	moderate	low	good	Hay, small grains, forest, pasture idle
Lcs	Uplands	6-15	Sloping phase	Lordstown acid chan-nery silt loam 6 to 8 in. thick	acid chan-nery silt loam 12 to 16 in. thick	None	acid stony silt loam; bedrock generally at about 3 feet	Shallow	good	moderate	low	fair	Forest, hay grains, idle pasture
Vcs	Uplands	9-15	Sloping phases	Volusia channery & grav-elly silt loam 4 to 8 in. thick	acid silt loam strongly mottled 8 to 15 in. thick	heavily mottled channery acid com-pact silt loam 10 to 15 inches thick	compact acid gravelly or chan-nery silt loam	moder-ately deep	poor	moderate	low	poor	Forest, hay pasture, idle small grains

TABLE V-10 (Cont'd)

MAP SYMBOL	TOPO-GRAPHIC POSITION	SLOPE	SOIL	SURFACE SOIL	SUBSOIL	HARDPAN	PARENT MATERIAL	DEPTH	DRAIN-AGE	EROSION	NATURAL FERTIL-ITY	WORK ABIL-ITY	PRESENT USE
Bcs	Uplands	6-15	Sloping phase	Both channery strongly acid loose silt loam 8 to 10 in. thick	strongly acid loose channery silt loam 12 to 18 in. thick	None	compact channery silt loam acid bed-rock at 10 ft. or more in most places	Deep	good	moderate	low	good	Hay, for pasture
Cdr	Uplands (valley walls)	9-16	Rolling phase	Confield gravelly silt loam about 8 in. thick	acid silt loam 12 to 16 in. thick	compact gravelly silt loam 10 to 15 in. thick	moderately compact gravelly silt loam; acid many feet thick some material not of local origin	Deep	moder-ately good	moderate	low	good	Hay, sma grains, pasture, forest

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TABLE V-11

APPLICATION RATES FOR SLUDGE AND SECONDARY EFFLUENT

	Land Type	Application Rate	Application Method and Period
SLUDGE	Grass	5,000 gal/day/acre	Surface application--5 days/ year (spring--1 day; after every cutting--3 days, fall-- 1 day)
	Crops (Corn)	5,000 to 8,000 gal/day/acre	Incorporate into the soil-- May 8,000 gal/day/acre. Side dressing between or beside the crop rows--June (late): 5,000 gal/day/acre. July (late): 5,000 gal/day/acre. Incorporate into the soil-- October 7,000 gal/day/acre.
	Forest	2,500 gal/day/acre	Surface application--10 days/year (April--October)
SECONDARY EFFLUENT	Grass	1.7 inches/week	Spray irrigation 7 months
	Crops	1.7 inches/week	Spray irrigation 6 months
	Forest	1.7 inches/week	Spray irrigation 6 months

CHAPTER VI

INDUSTRIAL WASTEWATER MANAGEMENT

Although the Bicounty Area does not support large "water--oriented" industries such as steel producers or pulp and paper mills using many million gallons of water every day, the investigati n of the characteristics of the smaller industries and manufacturers was still an important consideration in wastewater management planning. This chapter examines Federal guidelines for the discharge of industrial wastewater and describes the existing situation in the Bicounty Area. The National Pollutant Discharge Elimination System is discussed briefly, accompanied by a listing of local regulations regarding discharge of industrial wastewaters.

GUIDELINES FOR THE DISCHARGE OF INDUSTRIAL WASTEWATER

In accordance with the Federal Water Pollution Control Act Amendments of 1972, the EPA has published guidelines for different categories of industries. Most of these guidelines have been periodically amended into regulations. Effluent guidelines are set to achieve the reduction of industrial pollutant discharge directly to streams. Pretreatment guidelines are set for industries discharging to municipal wastewater treatment plants.

The limitations on direct effluent discharge to streams or rivers are set to attain the pollutant reduction possible by the application of the Best Practicable Control Technology Currently Available (BPT) by 1977, and the Best Available Control Technology Economically Achievable (BAT) by 1983. Under the National Pollutant Discharge Elimination System (NPDES), any industry or municipality discharging effluent to rivers or streams has to obtain a discharge permit. This discharge permit sets the limitations on pollutant loads that

can be discharged to the stream. These limitations are set after considering numerous factors: the nature of industries, amount of product manufactured, process of manufacturing, age of the plant, water usage, and stream classification at the discharge point. The discharge permit is set on an individual case basis.

The EPA has also published pretreatment standards to be followed by industries before discharging to municipal treatment systems. These standards are designed to protect the operation of publicly-owned treatment works, and to prevent the introduction of incompatible pollutants into publicly-owned treatment works which would pass through such works inadequately treated. No pretreatment is required for compatible pollutants such as BOD, SS, and fecal coliform bacteria unless required by State or local government.

EXISTING SITUATION

DISCHARGES TO RIVERS AND STREAMS

Table VI-1 summarizes the major industrial discharges into streams and rivers in Broome and Tioga Counties, and Figure VI-1 locates these discharges with reference to the Susquehanna and Chenango Rivers. Total discharge from the industries amounts to about 94 mgd. Approximately 87 percent (83 mgd) of the total industrial wastewater discharged directly to streams is relatively non-polluted cooling water. Major industries discharging to streams are the plating industry, gravel washing operations, power plants, photographic equipment and supplies manufacturing, and aerospace control systems equipment manufacturing. The GAF plant in Binghamton, listing "L" on Table VI-1, is now constructing a small plant to pretreat its process water (1.0 mgd) before direct discharge to the municipal sewerage system for further treatment at the Binghamton-Johnson City STP. Process wastewater for various industries is broken down into different categories and wastewater characteristics for these discharges are described in the following paragraphs.

TABLE VI-1
SUMMARY OF INDUSTRIAL DISCHARGES*
TO RIVERS AND STREAMS

NO.	NAME	QUANTITY (mgd)	TYPE	DISCHARGE LOCATION**
A1	IBM, Owego	0.3-0.6	Treated Plating Waste	S.R. (MP 18.4)
A2	IBM, Owego	0.02-0.06	Cooling	S.R. (MP 18.5)
B	Robintech, Inc. Owego	0.10	Plating Waste	Barnes Creek
C1	IBM, Glendale	0.038	Cooling	Nanticoke Creek
C2	IBM, Glendale	0.13	Cooling	Nanticoke Creek
D	Union Forging, Endicott	0.15	Cooling	S.R. (MP 31.5)
E	IBM, Endicott	2.52 1.80	Treated Plating Waste Cooling	S.R. (MP 32.5) via storm sewers
F	Endicott Forging and Manufacturing, Endicott	0.014 0.022	Cooling	S.R. (MP 32.7) via storm sewers
G	GAF, Vestal	0.02	Cooling	Willow Run Creek via Small Creek
H	Barney & Dickinson, Vestal	1.0	Gravel washing, after settling	S.R.

NO.	NAME	QUANTITY (mgd)	TYPE	DISCHARGE LOCATION**
I	GE, Johnson City	0.23	Cooling process	Little Choconut Creek
		0.49		Little Choconut Creek
J_1	NYSE & G, Johnson	79.1	Cooling	Little Choconut Creek
J_2	City	2.23	Ash Pond Discharge	Little Choconut Creek
K_1	Endicott-Johnson	0.45	Cooling	Little Choconut Creek
K_2	Johnson City	0.40	Ash Pond Discharge	via storm sewer
L	GAF, Binghamton	1.0	Process	Chenango River via
	GAF, Binghamton	3.48	Cooling	storm sewer
	Corbisell Quarries, Vestal ***	0.02	Gravel washing after settling	S.R. via unnamed creek
	Allred Asphalt, Vestal***	0.22	Cooling	S.R. via unnamed creek
	Central Asphalt***	0.0011	Cooling	S.R. via unnamed creek
	TOTAL	93.91		

* See Figure VI-1 for location.
** S.R. = Susquehanna River; MP = mile point from New York-Pennsylvania border near Waverly.
*** Not shown on map.

MAJOR INDUSTRIAL DISCHARGES

SEE TABLE VI-1 FOR KEY TO INDUSTRIAL DISCHARGES

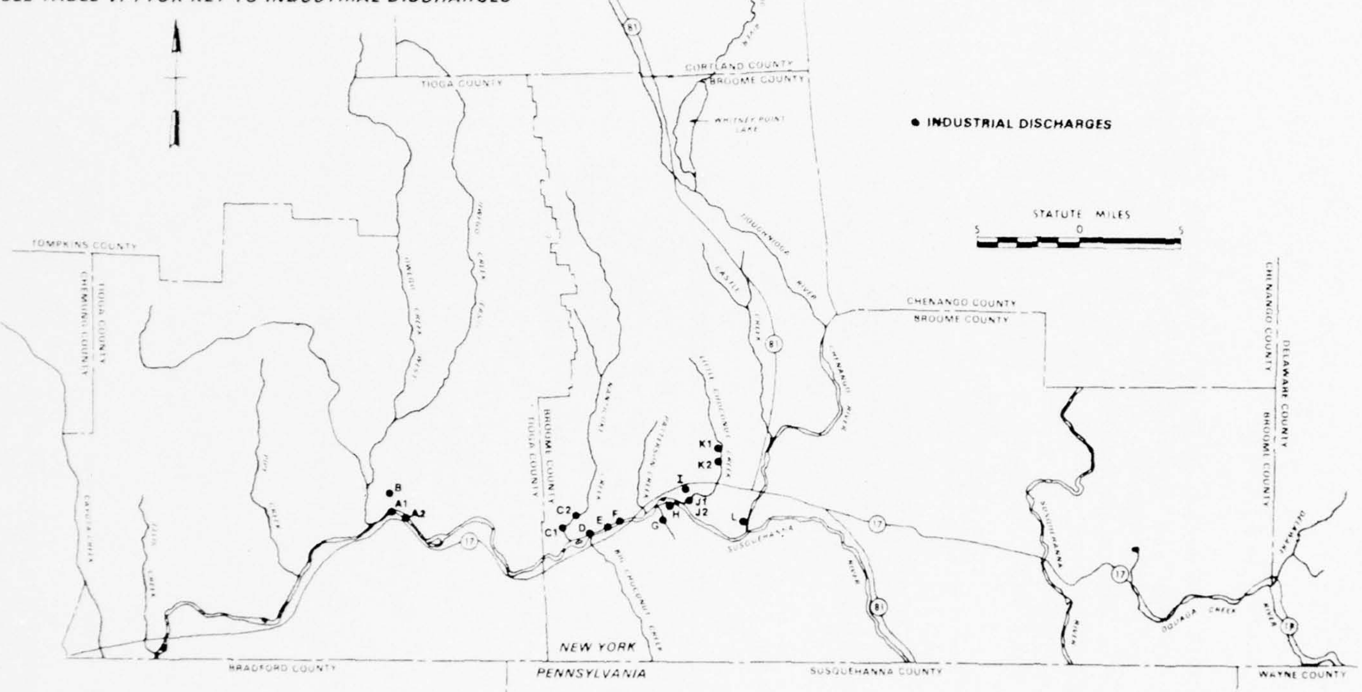

FIGURE VI-1

Plating Wastes

IBM, Endicott, 2.52 mgd

The effluent receives physical/chemical treatment (chemical precipitation and coagulation and settling) before discharge. Effluent quality of the discharge is presented in Table VI-2. Major pollutants, copper and chromium, in the discharge averaged 0.814 and 0.165 mg/l, respectively. Suspended solids concentration in the discharge is on an average less than 13 mg/l or 27 pounds per day.

IBM, Owego, 0.3-0.6 mgd

Table VI-3 presents effluent characteristics for the IBM Electric Systems Center in Owego. This effluent also receives physical/chemical treatment before discharge. Major pollutants are cooper and iron.

Robin Tech., Inc., Owego, 1.0 mgd

Untreated plating waste is discharged to Barnes Creek upstream of its confluence with the Susquehanna River. No definite plans for treating the wastewater were available. However, 1977 requirements will probably dictate that the industry provide treatment similiar to IBM's process (mentioned above) or provide pretreatment prior to discharge to a municipal system.

Ash Pond Discharges

New York State Electric and Gas Company, Johnson City, 0.92 mgd

Table VI-4 summarizes the effluent quality of the ash pond discharge. The discharge contains mainly unsettled fly ash dust. Suspended solids discharge is approximately 235 pounds per day.

Endicott Johnson, Johnson City, 0.40 mgd

No effluent quality results were available. The major pollutant would be inert SS load. Assuming SS concentration of 15 mg/l, on an average, 52.5 pounds per day of solids would be discharged to the river.

TABLE VI-2
IBM CORPORATION, ENDICOTT PLANT
EFFLUENT CHARACTERISTICS

TREATED PLATING WATER

PARAMETER	MINIMUM	AVERAGE	MAXIMUM
Flow (mgd)	0.455	2.52	2.88
pH	5.5	7.84	9.73
Suspended Solids (ppm)	2.7	12.9	32.0
Copper (mg/l)	0.10	0.814	6.5
Iron (mg/l)	0.02	0.252	0.59
Chrome (Hexavalent) mg/l	0.008	0.0294	0.293
Chrome (Total) mg/l	0.061	0.165	0.84

COOLING WATER DISCHARGE

PARAMETERS	DISCHARGE 001	DISCHARGE 002
	AVERAGES	
pH	6.97	7.6
Settleable Solids mg/l	-	0.34
Temp. ^{o}c	23.1	19.8
Flow, (gpd)	30.7	122.3
Zn, mg/l	0.115	--

TABLE VI-3

IBM ELECTRIC SYSTEMS CENTER, OWEGO
EFFLUENT CHARACTERISTICS

Discharge 001 - 0.012 mgl (ave) Process Waste

Parameter	Discharge Ave. Concentration	Ave. Pounds
Nickel (mg/1)	0.02	0.068
Zinc (mg/1)	0.042	0.142
Chromium (mg/1)	0.010	0.03
Copper (mg/1)	2.70	9.3
Iron (mg/1)	0.680	2.3
Chloride (mg/1)	50	170
Sulfite (mg/1)	250	850
Lead and Cyanide	absent	absent
Algicide* (mg/1)		50-100
Fluoride (mg/1)	0.48	1.6

Discharge 002 - Cooling Tower Blowdown

Parameter	Intake	Discharge Average	Maximum
Flow (grd)	680,000	405,000	802,000
pH	7.6	7.8	9.2
T winter (^{o}c)	7.0	18.0	24.0
T summer (^{o}c)	10.0	23.5	26.0

* Caigon H-212 and H-133 added on alternate weeks

TABLE VI-4

NEW YORK STATE ELECTRIC AND GAS COMPANY,
JOHNSON CITY; EFFLUENT CHARACTERISTICS

Ash Pond Discharge

Parameters	Minimum	Average	Maximum
Flow (MGD)	0	0.918	2.16
Suspended Solids (mg/l)	5	30.67	73.
Settleable Solids (mg/l)	0.01	0.05	0.30
pH	6.8	7.8	8.6
Iron (Fe) (mg/l)	0.4	0.40	0.40

Cooling Water Discharge

Cooling Water:	Parameters	Minimum	Average	Maximum
	Flow (MGD)	19.7	79.1	98.4
	Intake Temp. °F	57.7	60.3	65.9
	Discharge Temp. °F	75.6	80.7	90.3

Gravel Washings

Barney and Dickinson, Vestal, 1.0 mgd

Main pollutants discharged to the river are inert inorganic solids from gravel operations. The effluent is allowed to settle in settling ponds before discharge. Part of the effluent is recycled and reused. No SS analysis of an effluent was available to determine the solids load to the river.

Carbiselo Quarries, Vestal, 0.20 mgd

The effluent is allowed to settle in settling ponds before discharge. Main pollutants are inert inorganic solids. No SS analysis was available to determine the solids load.

Other Wastes

GAF, Binghamton, 4.48 mgd

GAF produces photo sensitive films and papers and film processing equipment. The nature of the waste is quite complex. Table VI-5 summarizes the wastewater characteristics of the effluent. The process waste (1.0 mgd) is diluted due to cooling water discharge (3.48 mgd), so the concentrations presented in Table VI-5 have a dilution factor of about 4.5. BOD and total solids loads discharged to the river are 1,850 and 25,560 pounds per day, respectively. GAF is completing construction, of a physical/chemical type (chemical coagulation and settling) pretreatment system. GAF will treat its 1.0 mgd of process wastewater before discharging it to sanitary sewers for further treatment at Binghamton-Johnson City STP.

General Electric, Johnson City, 0.49 mgd

General Electric manufactures electrical and electronic equipment for aerospace control systems. Table VI-6 represents the process waste characteristics. Waste contains low SS, 4 mg/l; and heavy metals, nickel, copper, and chromium, 0.17, 0.06, and 0.11 mg/l, respectively. However, it discharges 46.3 pounds per day of total oily matter.

TABLE VI-5

GAF CORPORATION, BINGHAMTON
EFFLUENT CHARACTERISTICS

PARAMETER	MINIMUM	AVERAGE	MAXIMUM
pH mg/l	6.8	7.6	8.9
Total Solids	586.	684.	987.
Color (mg/l)	0.0	60.	241.
Turbidity (mg/l)	0.0	49.	145.
Cu (mg/l)	0.0	0.103	2.14
Cr (mg/l)	0.0	0.040	0.30
ZN (mg/l)	0.0	0.189	0.62
Ag (mg/l)	0.05	1.567	7.80
Fe (mg/l)	0.0	0.89	3.70
Cn (mg/l)	0.0	0.054	0.75
Chlorides (mg/l)	53.2	85.8	113.60
Sulfates (mg/l)	0.0	1.47	10.00
PO_4 (mg/l)	0.20	1.85	5.5
COD (mg/l)	0.0	82.	205.6
BOD_5 (mg/l)	2.0	49.5	127.9
Temp (^oC)	3.0	15.2	20.2
Flow (MDG) Total	2.2	4.48	6.0
Process	-	1.0	-

TABLE VI-6

GENERAL ELECTRIC, JOHNSON CITY
EFFLUENT CHARACTERISTICS

PROCESS WASTE CHARACTERISTICS	AVERAGE	RANGE
Flow (MGD)	0.491	0.241 - 1.06
D.O. mg/l	9.28	7.0 - 13.0
pH		7.3 - 7.5
Temp. °F	65.1	54-73
Settleable Solids, mg/l	0.10	<0.1 - 0.5
Suspended Solids, mg/l	3.67	0.3 - 11.5
Total oil matter, mg/l	11.31	2.8 - 45.0
Cyanide, mg/l	0.015	<.01 - 0.02
Nickel, mg/l	0.168	0.02 - 0.5
Copper, mg/l	0.058	0.01 - 0.13
Chromium, total, mg/l	0.110	0.01 - 0.78
Chromium, hexavalent, mg/l	0.043	<0.01 - 0.65
Cooling Water Flow, MGD	0.230	0.150 - 0.350
Temp. °F	56.	45 - 60

Union Forging Company, Endicott, 0.15 mgd

Effluent characteristics for the Union Forging Company in Endicott are given in Table VI-7. Primary pollutants are iron, total solids, hardness, and chlorides.

Filtration Plant, City of Binghamton, 0.5 mgd

The City of Binghamton receives its water supply from the Susquehanna River. The water is filtered and periodically the filters are backwashed and the residue discharge to the Susquehanna. Effluent characteristics are listed in Table VI-8. By 1 July 1977, all surface water discharge from the filtration plant must cease. This requirement will probably involve discharge to the sanitary sewer system.

DISCHARGES TO MUNICIPAL SEWERAGE SYSTEMS

Table VI-9 summarizes the major industries in Broome and Tioga Counties requiring pretreatment before discharging to municipal treatment systems. As indicated on Table VI-9, present industrial connections to municipal systems are not large water users. Dairy processing and the beverage industries place the biggest demands on the system. GAF in Binghamton will soon add its 1.0 mgd of pretreated process wastewater to the municipal system for the Binghamton-Johnson City STP. The Frito-Lay plant in Five Mile Point has recently connected to the Binghamton system, and is assessed a surcharge because of its high strength sewage (maximum BOD and suspended solids about 5,600 lbs/ day and 7500 lbs/day, respectively). Average flow from the Frito-Lay plant is about 0.29 mgd.

To date, few severe problems have been observed at the municipal STP's directly attributable to industries. The Endicott STP has had some recent problems with heavy metals being discharged to the plant. This observation was based in part on the poor treatment efficiency (possible toxicity of heavy metals) and also on an analysis of the plant's sludge. It is assumed that the heavy metals occur as a result of an industry or industries not meeting pretreatment requirements. Strict monitoring of industries discharging to the Endicott STP and enforcement of the pretreatment requirements established by P. L. 92-500 will help to reduce and/or eliminate the heavy metals problem.

TABLE VI-7

UNION FORGING COMPANY, ENDICOTT
EFFLUENT CHARACTERISTICS

Flow	0.15 MGD
pH	7.2
T Winter	50^oF - 85^oF
T Summer	55^oF - 95^oF
Turbidity	20 ppm
Iron	4.2 mg/l
CO_2	4.0 mg/l
Total Solids	888 mg/l
Chlorides	240 mg/l
Hardness ($CaCO_3$)	162 mg/l

TABLE VI-8

BINGHAMTON FILTRATION PLANT
EFFLUENT CHARACTERISTICS

Average Flow	-	0.5 MGD
pH	-	6.6
Temperature	-	$43^{\circ}F$ (winter
	-	$78^{\circ}F$ (summer)
BOD_5	-	3 ppm maximum concentration
	-	12.5 lbs. ave. per backwash
SS	-	127 ppm maximum concentration
	-	530 lbs. ave. per backwash
color	-	20 units ave.
	-	200 units max.
Turbidity	-	40 units ave.
	-	500 units max.

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TABLE VI-9

SUMMARY OF INDUSTRIES REQUIRING PRETREATMENT BEFORE DISCHARGE TO SANITARY SEWERS

INDUSTRY	TYPE OF WASTE	WATER CONSUMPTION MILLION GAL/DAY
Ashland Chemical Co. 3 Broad Street Binghamton	Organic Chemical	.002
Binghamton Coca-Cola Bottling Co. 7 Walter Avenue Binghamton	Beverage Industry	.011
Bonnie Silk Co., Inc. 39 Milford Street Binghamton	Mfg. of fabrics from wool, cotton and synthetic fibers	.001
Canada Dry Bottling Co. of Southern N.Y., Inc. 7 Badger Avenue Endicott	Beverage Industry	.045
Crowley Foods, Inc. 145 Conklin Avenue Binghamton	Dairy Products	.081
Crystal Soda Water Co. 184 Moeller Street Binghamton	Beverage Industry	.001

TABLE VI-9 (Cont'd)

INDUSTRY	TYPE OF WASTE	WATER CONSUMPTION MILLION GAL/DAY
Dairylea Corp., Inc. 12 Jackson Street Binghamton	Dairy Product	.037
Hofman Meats Inc. 10 Olive Street Johnson City	Meat Processing Waste	.001
Industrial Electro- platers, Inc. 172 State Street Binghamton	Metal Finishing	.044
Pepsi Cola Binghamton Bottling Co., Inc. 5 Broad Avenue Binghamton	Beverage Industry	.005
7-Up Bottling Co. of Binghamton 149 Main Street Binghamton	Beverage Industry	.017

TABLE VI-9 (Cont'd)

INDUSTRY	TYPE OF WASTE	WATER CONSUMPTION MILLION GAL/DAY
(TIOGA COUNTY)		
International Stock Flood Corp. 533 Broad Street Waverly	Pharmaceutical Industry	Not available
Waverly Creamery, Inc. 446 Broad Street Waverly	Dairy Product Industry	Not available

The Binghamton-Johnson City STP, on the other hand, has an influent flow with a suspended solids concentration considerable higher than for normal strength domestic sewage. The sludge handling capability (vacuum filtration) of the plant is presently at or near capacity. An increased volume of wastewater flow in the future might mean that the plant could not handle the increases in suspended solids load. Although regulations do exist regarding excessive suspended solids discharge, certain industries and/or municipalities may not be complying with the regulations.

Although neither problem is great, they are constant sources of concern to the STP operators. Stricter monitoring and stronger enforcement of EPA regulations and local ordiances could help alleviate such problems at both the Binghamton-Johnson City STP and the Endicott STP.

CURRENT REGULATIONS

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMITS

Under the National Pollutant Discharge Elimination System (NPDES), established by PL 92-500, all discharges to surface waters must obtain a permit. Applications for permits usually list existing discharges and treatment techniques, while the permits themselves describe what levels of effluent quality must be achieved at various benchmark years. Generally, the permits do not specify required treatment techniques. Table VI-10 lists the discharge permit applications within the Bicounty Area. Although most of the permits concern industrial wastewater sources, the permits for the municipal wastewater treatment plants (Binghamton-Johnson City, Endicott, Vestal, Owego #2, Owego #1, and Owego Village, as well as the storm discharges from Binghamton's sewer system) are listed since publicly owned treatment works must also obtain a permit. Most of the initial permits have been granted for five years, except for the STP's which generally only extend to 30 June 1977.

DISCHARGE PERMIT APPLICATIONS

	NAME	PERMIT NUMBER	COMMENTS
1.	Binghamton-Johnston City Joint Sewage Board	NY0024414	Municipal sewage treatment plant.
2.	City of Binghamton	NY0024406	Discharges from sewer system (during storm)
3.	City of Binghamton Filtration Plant	NY0025542	Water supply filter backwash
4.	City of Binghamton Water Plant	NY0008664	
5.	Endicott-Johnson Corp.	NY0004383	Process wastes
6.	Exxon Corp. (Johnson City)	NY0025810	Petroleum facility runoff
7.	GAF Corp. Industrial Photo	NY0004022	Process and cooling discharges
8.	GAF Corp Vestal Plant	NY000403	Cooling discharges
9.	G.E. Co., Aerospace Industries	NY0004375	Process wastes
10.	General Services Admin. Public Bldgs Services	NY0025615	Primary Treatment of sanitary effluent
11.	Grand Union Warehouse	NY0028941	Leach field runoff

TABLE VI-10 (Cont'd)

	NAME	PERMIT NUMBER	COMMENTS
12.	IBM Electric Systems Center	NY0004057	Process and cooling discharges
13.	IBM Corp. SPD Laboratory	NY0003905	Cooling and boiler discharges
14.	IBM Corp. Systems Management Division	NY0003808	Process
15.	IBM Country Club and Homestead Facility	NY0022004	Application deleted
16.	International Business Machine Corp. (Endicott)	NY0020788	Application deleted
17.	Johnson City Sewerage System	NY0023981	Discharges from sewer system
18.	N.Y. State Elec. & Gas Goudey Station	NY0003875	Cooling water
19.	Rose Stone Corp.	NY0003832	Settling and discharge
20.	State U. of New York at Binghamton	NY0004391	Cooling and boiler discharges
21.	Texaco, Inc. (Vestal)	NY0028380	Petroleum facility runoff
22.	Town of Dickinson	NY0021415	

TABLE VI-10 (Cont'd)

	NAME	PERMIT NUMBER	COMMENTS
23.	Town of Owego (WPCP #2)	NY0025798	Municipal sewage treatment plant
24.	Town of Owego (WPCP #1)	NY0022730	Municipal sewage treatment plant cooling water
25.	Union Forging Co.	NY0004375	
26.	Town of Vestal	NY0028258	Primary plant and pump overflows
27.	Village Ballon Press Inc.	NY0004197	Application deleted
28.	Village of Deposit	NY0029211	Municipal sewage treatment plant
29.	Village of Port Dickinson	NY0023817	Application deleted
30.	Village of Owego	NY0029262	Municipal sewage treatment plant
31.	Village of Endicott	NY0027669	Municipal sewage treatment plant

LOCAL REGULATIONS

The following section summarizes existing local regulations governing the discharge of wastes into specific publicly owned treatment works in the Urban Study Area. Only pertinent sections related to the discussion at hand are included.

City of Binghamton--Local Law No. 2 of 1967

Section 7.

"Industrial Waste" shall mean and include any liquid, gaseous, solid, or other waste substance of a combination thereof resulting from any process of industry, manufacturing, trade, or business, or from the development or recovery of any natural resources.

Section 34.

It shall be unlawful to discharge to any natural outlet within the City or in any area under the jurisdiction of said City, any sanitary sewage, industrial wastes or other polluted waters, except where suitable treatment has been provided in accordance with the subsequent provisions of this local law, the public health law, and regulations of the New York State Department of Health, and the Broome County Health Department.

Section 35.

So far as is practicable, industrial waste shall be discharged into the City's sewer system with or without pretreatment, provided the consent of the City Engineer is first obtained, and the rules, regulations, and standards hereinafter prescribed are complied with, in the judgment of the Engineer.

Section 36.

Written approval by the City Engineer is required for all new discharges of industrial wastes after the effective data of this local law. These shall include all wastes in which the quantity, temperature, or chemical characteristics are altered in operation procedures and equipment changes.

Section 37.

The discharge of industrial cooling water to the City's sewer system is not permitted except by specific written approval by the Engineer.

Section 53

No person shall discharge or cause to be discharged to any public sewer any of the following described substances, materials, waters, or wastes:

(l) Any waters containing suspended solids of such character and quantity that unusual provision, attention, or expense is required to handle such materials at the sewage treatment plant.

(o) Any waters or wastes that for a duration of 15 minutes have a concentration great than five times that of "Normal" sewage as measured by suspended solids and BOD.

[illegible] Any concentrated dye wastes, spent tanning solutions, o[illegible] wastes which are highly colored, or wastes which [illegible] of unusual volume, concentration of solids or composition, for example: (1) total suspended solids of inert nature (such as Fuller's Earth), and/or (2) total dissolved solids (such as sodium chloride, calcium chloride, or sodium sulphate), or (3) unusual in BOD.

Section 54.

Notwithstanding the provisions of Section 53, any discharge into the public sewer of wastes, whose concentration of suspended solids, or BOD, or grease causes at the municipal sewage works a monthly increase in the average daily analysis of any of these constituents in excess of two percent of the annual daily average for the previous year, is prohibited.

Section 57.

The admission into the public sewers of any waters or wastes having the following characteristics shall be prohibited:

(a) A BOD of more than 240 parts per million; or

(b) A suspended solids content greater than 300 parts per million; or

(c) A quantity of substances having the characteristics described in Section 53; or

(d) An average flow greater than 10, 000 gallons per day and shall be subject to review and approval by the Engineer.

Where necessary, in the opinion of the Engineer, the owner shall provide, at his expense, such preliminary treatment as may be necessary to:

(a) Reduce the BOD to 240 parts per million and the suspended solids to 300 parts per million; or

(b) Reduce objectionable characteristics or constituents to within the maximum limits which are provided for in Section 53; or

(c) Control the quantities and rates of such discharge of waters and wastes.

Plans, specifications, and any other pertinent information related to the proposed preliminary treatment facilities shall be submitted for approval of the Engineer, and the New York State Department of Health. No construction of such facilities shall be commenced until said approvals are obtained in writing.

Section 58.

Where preliminary treatment facilities are provided for any waters or wastes, they shall be maintained continuously in satisfactory and effective operation by the owner, at his expense, and shall be subject to the periodic inspection by the Engineer. They shall be the type and capacity approved by the Engineer, and must produce an effluent conforming to the provisions of this local law. The owner shall maintain operating records and shall submit to the Engineer a monthly summary report of the character of the influent and effluent as may be prescribed by the Engineer to show satisfactory performance of the treatment facilities.

Section 61.

No statement contained in this Article shall be construed as preventing any special agreement or arrangement between the City and any industrial concern whereby an industrial waste of unusual strength of character may be accepted by the City for treatment subject to extra payment therefore by the industrial concern.

Amendment to Local Law No. 2 of 1967 (April 1968). (d) Subdivision (i) of Section 53 of said Local Law is hereby inserted therein, to be known as Section 53(i):

"Any waters or wastes containing a toxic or poisonous substance in sufficient quantity to injure or interfere with any sewage treatment process, constitute a hazard to humans or animals, or create any hazard in the receiving waters or storm water overflows or the effluent of the sewage treatment plant. Materials such as copper, zinc, chromium, and similar toxic substances shall be limited to the following average quantities in the sewage as it arrives at the treatment plant:

Iron as Fe-4 parts per million

Chromium as Cr Hexavalent-0.5 parts per million

Nickel as Ni-1 part per million

Copper as Cu-1 part per million

Cadium as Cd-0.1 parts per million

Zinc as Zn-3 parts per million

Lead as Pb-0.1 parts per million

Chromium as Cr-5.0 parts per million."

Amendment to Local Law No. 2 of 1967 (20 April 1970) (a) That the following words be added to Subdivision (i) of Section 53 of the said Local Law as amended:

"At no time shall the hourly concentration exceed three (3) times the average concentration, and with contributions for individual establishments subject to control in volume and concentration by the City Engineer."

Sanitary Sewer Ordinance for the Village of Endicott

This local law, in essence, is the same as the City of Binghamton's with the following exceptions:

Section 53.

No person shall discharge or cause to be discharged to any public sewer any of the following described substances, materials, waters, or wastes:

(i) Any waters or wastes containing a toxic or poisonous substance in sufficient quantity to injure or interfere with any sewage treatment process, constitute a hazard to humans or animals, or create any hazard in the receiving waters or storm water overflows or the effluent of the sewage treatment plant. Materials such as copper, zinc, chromium and similar toxic substances shall be limited to the following average quantities in the sewage as it arrives at the treatment plant:

Iron as Fe-4.0 parts per million

Chromium as Cr-0.5 parts per million

Nickel as Ni-1 part per million

Copper as Cu-1 part per million

Cadium as Cd-0.1 parts per million

Zinc as Zn-3.0 parts per million

Section 57.

The admission into the public sewers of any waters or wastes having the following characteristics shall be prohibited:

(a) A BOD of more than 300 parts per million; or

(b) A suspended solids content of greater than 400 parts per million; or

(c) A quantity of substance having the characteristics described in Section 53; or

(d) An average flow greater than 10,000 gallons per day and shall be subject to review and approval by the Engineer.

Where necessary, in the opinion of the Engineer, the owner shall provide, at his expense, such preliminary treatment as may be necessary to:

(a) Reduce the BOD to 300 parts per million and the suspended solids to 400 parts per million; or

(b) Reduce objectionable characteristics or constituents to within the maximum limits which are provided for in Section 53; or

(c) Control the quantities and rates of such discharge of waters and wastes.

Plans specifications and any other pertinent information related to the proposed preliminary treatment facilities shall be submitted for approval of the Engineer. No construction of such facilities shall be commenced until said approvals are obtained in writing.

Local Law of the Town of Vestal

The ordinance in this case is essentially identical to that of the City of Binghamton.

Village of Owego

The ordinance of the Village of Owego states that the maximum BOD concentration discharged by anyone is not to exceed 300 ppm.

CHARGES FOR INDUSTRIAL DISCHARGE

In addition to the above mentioned regulations, each industry is charged for discharging into the sanitary sewer system. There is a metered rate based on volume for the Binghamton-Johnson City, Vestal, and Owego Village STP's. The only industry receiving a charge by the Binghamton-Johnson City Joint Sewer Board is Frito-Lay because of its high strength waste.

The Village of Endicott and Town of Union do not have metered rates. The charges are obtained through property taxes. This type of revenue-collection provides no incentive to correct existing problems, and because of this, there does exist the possibility of illegal discharge of cooling water into the sanitary sewer system.

SUMMARY

Urban Study Area industrial wastes discharged to either surface water bodies and/or publicly owned treatment works do not appear to be a major problem based on either water quality in the streams or operation of the sewage treatment plants. However, some minor problems have been experienced at the Endicott STP because of heavy metals and at the Binghamton-Johnson City STP because of high influent suspended solids.

No future problems are anticipated if industries comply with EPA guidelines and local regulations. If there is noncompliance by the industries, then the problem becomes an institutional issue regarding enforcement powers. In any wastewater management plan, special consideration should be given to regulatory authority of the implementing agencies for enforcing the applicable water quality, effluent quality, or pretreatment standards.

CHAPTER VII

NONSTRUCTURAL MEASURES

COSTS AND EFFECTIVENESS

INTRODUCTION

Many measures and devices are available to conserve water, reduce wasteflow, and save energy in the home. Over the long run these measures will help to conserve consumption of water (pricing policy) and will save money on fuel, electric, sewage and water bills at little inconvenience to the individual. If water-saving measures are adopted on a community-wide basis, millions of gallons of water can be saved. These savings may delay the need for expensive water and wastewater treatment expansion, improve water quality by lessening the load on sewage treatment and septic tank systems, and help conserve our valuable resources.

THE NONSTRUCTURAL APPROACH

To utilize a nonstructural approach for a plan means to take into consideration, evaluate, and include elements such as pricing, public education, and/or information about various water-saving devices for the implementation of that plan.

Not only are there various non-structural measures available, but these nonstructural measures can attain different levels of achievement depending upon the particular plan desired. For example, Table VII-1 analyzes the effectiveness of two nonstructural measures: pricing and education, and relates the percentage of achievement to the different wastewater management plans for each service area. In analyzing this Table, however, it must be kept in mind that even though the levels of achievement of nonstructural measures depend on which plan is considered, the estimates of the effectiveness of the measures are not subject to any

TABLE VII-1

EFFECTIVENESS OF NON-STRUCTURAL MEASURES IN YEAR 1999 **

	ΔQp (MGD)	ΔQ_1 (MGD)	Percent Achievement
Binghamton			
2nd Treatment	0.00	1.10	23
5 mg/l Plan	0.22	1.10	31
BIO AWT	1.61	1.26	62
P/C AWT	2.28	1.26	75
Endicott			
2nd Treatment	0.00	0.70	37
BIO AWT	0.86	0.78	86
P/C AWT	1.35	0.78	100**
Chenango Valley			
2nd Treatment	0.00	0.21	46
5 mg/l Plan	0.03	0.21	53
BIO AWT	0.27	0.22	100**
P/C AWT	0.36	0.22	100**
East Owego			
2nd Treatment	0.00	0.18	35
BIO AWT	0.37	0.19	100**
P/C AWT	0.42	0.19	100**
West Owego			
2nd Treatment	0.00	0.08	33
BIO AWT	0.15	0.09	100**
P/C AWT	0.21	0.09	100**
Owego Village			
2nd Treatment	0.00	0.04	21
BIO AWT	0.14	0.05	100**
P/C AWT	0.20	0.05	100**

ΔQp -- Change in demand from Pricing

$\Delta Q1$ -- Change in demand from Education Program to encourage homeowners to install cost-effective plumbing devices to save water.

Percent Achievement -- Degree to which ΔQp and $\Delta Q1$ achieves the "non-structural alternative."

**What is considered to be 100 percent achievement of the nonstructural alternatives is any combination of measures which will maintain the estimated present per capita discharges to sewage treatment plants. By the year 2000, 100 percent achievement of the nonstructural alternatives would result in a 27 percent decrease in projected demand. Summary table of Lawler, Matusky, and Skelly analysis, September 1975, performed for the Binghamton Wastewater Management Study.

degree of certainty. Part of this uncertainty lies in the degree of use of the nonstructural measure, population changes, and personal income to mention only a few.

STUDY AREA PROJECTIONS

The Bicounty Study Area is characterized by a centralized urban core along the Susquehanna River containing the major metropolitan services and several Outlying Communities scattered across the two counties serving the agricultural areas. A complete study area profile is given in the Background Appendix as well as the derivation of the population projections for the Bicounty Area. Both the Plan Formulation Appendix and the Design and Cost Appendix contain projections of water use for the Urban Study Area.

Table VII-2 is a comparison of several studies for per capita water use trends and projections. Although the overall increases (projected and experienced) for this area over a 50 year period vary considerably, nevertheless, the projections collectively indicate an increase in consumption, but at a declining rate. Basically, the percent per decade increase in per capita flows is the following: 10 percent during the 1970's, 10 percent during the 1980's, 5 percent during the 1990's, and 0 percent for the year 2000 and beyond. These percentages were based on the references cited in Table VII-2 and on curves and data extracted from Basic Waterworks Management.

These projections represent the most reasonable assumptions of what might be expected to occur in the future given certain assumptions. These assumptions are:

1. Flow rates have nationally increased in the past and are expected to do so locally; and

2. There will be a level of water use beyond which the consumer will receive little additional utility.

Concerning domestic flows specifically, the projected increases can be applied to the various types of domestic sewage flow (laundry, shower, and so forth). Table VII-3 represents the proportion to which the various types of sewage flow constitute the 60 gallons per capita per day (gpcd) used as a base for the domestic projections.

TABLE VII-2

COMPARISON OF PER CAPITA WATER USE TRENDS AND PROJECTIONS

Study	Area	Increases Reported	Equivalent 50 Year Increase to Year 2020
1. Linaweaver	USA	About 9%/decade increase since 1900 estimated.	54% (To 1950)
2. TSC	Southern New York State	0.5 gpcd per year increase projected equivalent to initial increases of 4 1/2%/decade declining to 4%/decade.	22%
3. Holzmacher	Long Island, NY	General average increase of 2%/decade projected.	9%
4. Greeley & Hanson	Long Island, NY	6% per decade increases declining to 1 1/2%/decade increases projected.	15%
5. New Jersey	Northeastern New Jersey	9%/decade increases declining to 6% per decade increases projected.	44%
6. QLM Phase I	Binghamton, NY	10%/decade projected.	61%
7. LMS Phase II	Binghamton, NY	10%/decade declining to instant flow.	27%

References:

1. F. P. Linaweaver, et. al. A Study of Residential Water Use. (US HUD, 1967).
2. Temporary State Commission on the Water Supply Needs of Southeastern New York. Scope of Public Water Supply Needs. (1972).
3. Holzmacher, McLendon and Murrell. Suffolk County Comprehensive Water Supply Study. (1968)
4. Greeley & Hanson. Nassau County Comprehensive Water Supply Study. (1971)
5. New Jersey Division of Water Policy and Supply. Water Resource Circular 21. (1969)
6. Quirk, Lawler, and Matusky. Binghamton Wastewater Management Study: Phase I. (1974)

TABLE VII-3

IN-HOUSE DOMESTIC USE OF WATER

USE	Gallons Used Per Capita Per Day
Dishwashing	3.5
Cooking, Drinking	2.8
Utility Sink (Washing Hands, etc.)	1.2
Laundry	8.2
Bathing	18.8
Bathroom Sink	1.9
Toilet	23.5
TOTAL	59.9

SOURCE: "Water Conservation and Waste Flow Reduction in the Home," William Sharp; Penn State University; Special Circular 184, College of Agriculture.

NONSTRUCTURAL MEASURES

There are several nonstructural measures that can be taken to help reduce water consumption. These range from measures of general applicability to specific measures for domestic, commercial, and industrial establishments. The first two measures discussed are the ones with general applicability. The remaining measures will be those of a specific nature.

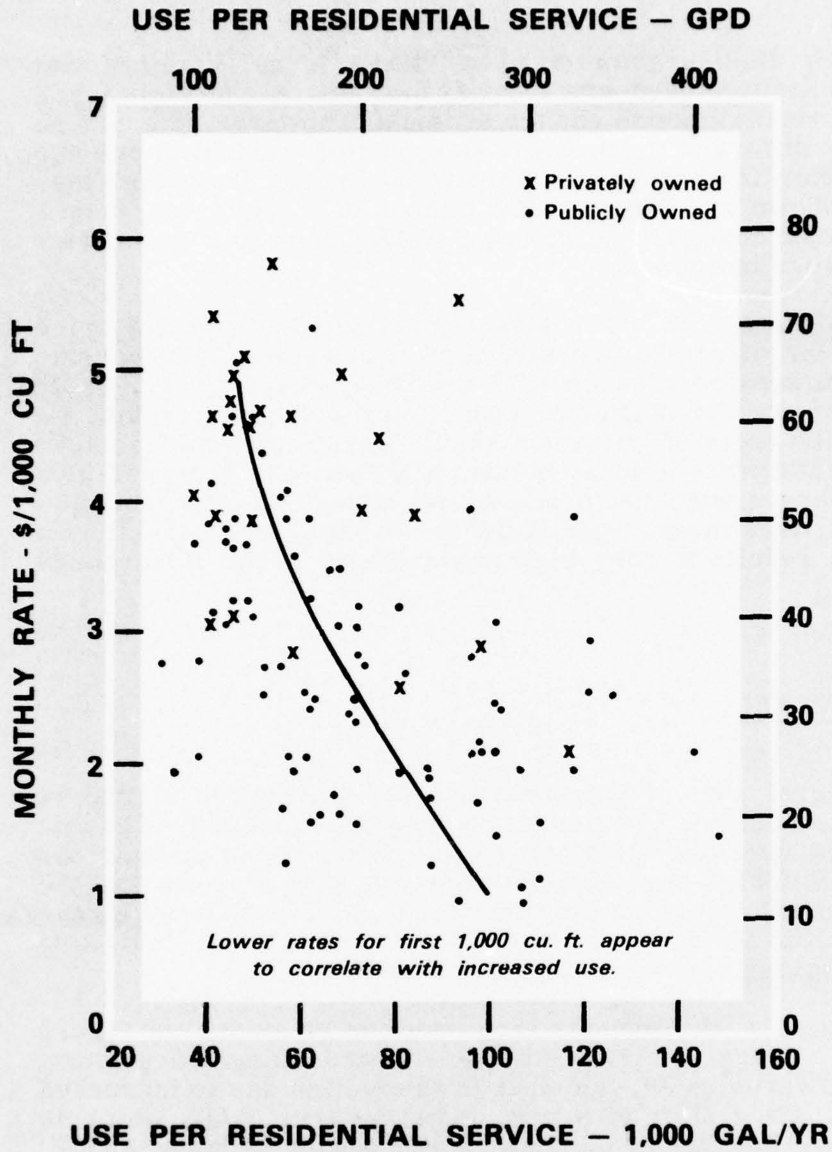
PRICING THEORY

Once an area is metered, pricing for water and sewage service is the next step in reducing flows. The concept is the more one has to pay for per unit of commodity, the less one demands of the commodity. (Once again, it must be remembered that the analysis of water pricing is subject to the same imprecisions noted earlier).

In pricing water use, domestic uses are generally studied separately from the non-domestic uses because non-domestic water users (commercial establishments, industries, etc.) theoretically will try to maximize profits by considering water as a substitute commodity for labor and capital investments whenever the price differentials between these commodities change.

Domestic users, on the other hand, do not maximize profits, but rather relate the consumption of this commodity at an increased price with constraint on personal income. Thus, an increase in the price of water may not necessarily reduce water consumption but may reduce, for example, the number of times an individual may go to the theater. The distinction between domestic and non-domestic water users become important in a later section as different price elasticities were derived for both categories of use.

Several general pricing studies have been conducted to try to affix costs to levels of water consumption. However, there is no great agreement among researchers in demand responses to price changes both for domestic and non-domestic use. For example, in terms of domestic use, Figure VII-1 demonstrates the variability that can be expected between demand and price. The percent amount by which water consumption is reduced by a 1 percent change in price is called the "price elasticity of demand for water."



SOURCE:

Seidel and Baumann. "Statistical Analysis of Water Works, Data." JAWWA (December 1957)

FIGURE VII - 1

EFFECTS OF PRICES ON RESIDENTIAL WATER USE

Even for the Binghamton area, there is no certainty that the elasticities used are actually correct. A change in price should result in some change in demand; however, the change will be different from one area to another and from one use to another in each area. More importantly, the price elasticity shown on Figure VII-1 (about 0.3) indicates that a significant change in price is necessary to produce a moderate change in demand.

Tables VII-4 and VII-5 demonstrate the incremental price levels for domestic and non-domestic water and sewer use for each service area for 1977 and 1999, respectively. Table VII-6 shows the degree of reduction which pricing alone (to cover the costs of treatment plant operation) would achieve for the 100 percent nonstructural alternatives. For example, secondary treatment produces no change in demand. Advanced treatment, particularly at the small treatment plants, results in very high achievement of the flow reduction.

EDUCATION

An integral part of the nonstructural alternative is that of public education. The education programs considered in this analysis are two-fold: one effort would be to educate the public to install more efficient water saving devices, and the other effort would be a major campaign to encourage people to use less water than they normally would by installing water saving devices and by using less water.

Conceptually, the changes in demand can be studied in Figure VII-2. There is: (1) a shift in demand along the existing demand curve, ΔQP, which is the reduction due to increased prices, (2) a shift to a new demand curve, $\Delta Q1$, which is the reduction due to domestic water saving devices, and (3) a shift in demand below the device-adjusted demand curve, $\Delta Q2$, which is the reduction due to convincing people to make a decision which may not be economical for them individually, or otherwise rewarding.

The shift, as a result of pricing, requires no direct expenditures on the part of an implementary or planning agency. Given that the costs must be recovered, the impacts of pricing are generally small compared to other recovery arrangements. Each user makes an individual choice to maximize his utility. This maximization may take place by reducing water consumption, or maintaining consumption and

TABLE VII-4

1977 INCREMENTAL PRICES OVER 1973 LEVELS
(¢/1000 gallons)

	Domestic		Non-Domestic	
	Water	Sewer	Water	Sewer
Binghamton	53	35.0	30	35.0
Endicott	54	9.5	30	9.5
Chenango Valley	40	21.6	30	21.6
East Owego	70	23.8	30	23.8
West Owego	90	26.4	30	26.4
Owego Village	86	24.0	30	24.0

TABLE VII-5

1999 INCREMENTAL PRICES OVER 1977 LEVELS
(¢/1000 gallons)

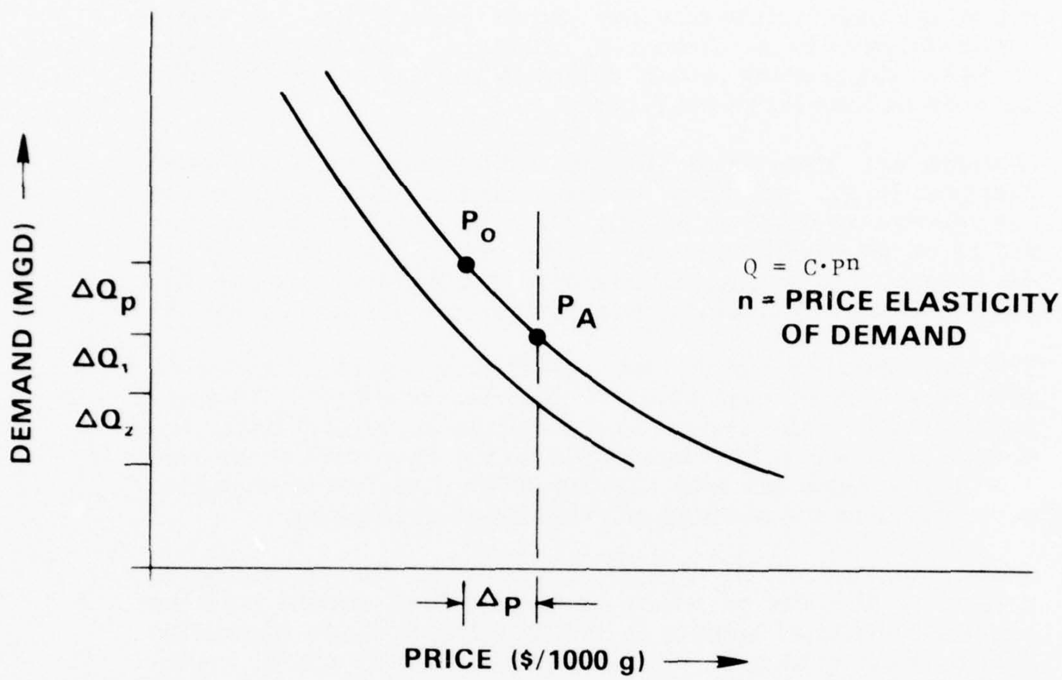
	Domestic		Non-Domestic	
	Water	Sewer	Water	Sewer
Binghamton	53	28.0	30	28.0
Endicott	54	7.9	30	7.9
Chenango Valley	40	14.8	30	14.8
East Owego	70	14.0	30	14.0
West Owego	90	14.8	30	14.8
Owego Village	86	16.0	30	16.0

TABLE VII-6

1999 TOTAL FLOW (MGD) REDUCTIONS

	From Price Changes 2nd	Nit	Bio	Non-Structural 100% Reduction	Total Flow Expended without Flow Reduction Measures
Binghamton	0.0	.22	1.16	3.7	24.5
Endicott	0.0	---	8.60	1.7	8.9
Chenango	0.0	.03	0.27	0.4	2.0
East Owego	0.0	---	0.37	0.5	2.5
West Owego	0.0	---	0.15	0.1	0.5
Owego Village	0.0	---	0.14	0.0	0.9
				6.4	39.3

DEMAND - PRICE - EDUCATION RELATIONSHIP



100% ACHIEVEMENT OF NON-STRUCTURAL FLOW REDUCTION MEASURES $= \Delta Q_p + \Delta Q_1 + \Delta Q_2$

ΔQ_p = DEMAND CHANGE ASSOCIATED WITH AN INCREASE IN PRICE TO COVER COSTS OF AN ALTERNATIVE (NO ALTERNATIVE COST)

ΔQ_1 = CHANGE TO NEW DEMAND CURVE ASSOCIATED WITH EDUCATION PROGRAM FOR AN ECONOMIC DECISION BY HOMEOWNERS TO ALTER PLUMBING TO SAVE THEIR OWN MONEY (SMALL ALTERNATIVE COST IN EDUCATION)

ΔQ_2 = CHANGE IN DEMAND CREATED, BY MAJOR EDUCATION PROGRAMS, BELOW WHAT WOULD BE WILLINGLY PAID FOR (MAJOR EDUCATION COST, & SOCIAL COST $= \Delta Q_2 \cdot P_A$)

FIGURE VII-2

reducing consumption of some other commodity, or some combination of both. However, changing consumption patterns by decreasing water demands may cause inequitable impacts across large study area.

If costs are recovered through other than metered user charges (e.g., property taxes), then an individual would not receive as much a benefit from his reducing water consumption as would normally be achieved. Therefore, given the price, the pricing alternative is considered to be the base against which other alternatives should be compared.

The expenditures which may result to a non-domestic user as a result of the pricing must also be considered. The expenditures are about equal to the change in demand times the change in price if the industry's price elasticity is strong. That is, a business will usually allow itself to incur added costs equal to the savings of reducing consumption.

Other than the small direct expenditures for an education program, the use of water saving devices should have an overall beneficial impact to the individual, since he will be able to make economic decisions not normally made. Normally, these decisions will also relate to decreasing the use of water as well as installing water saving devices.

Costs of the Education Program

The costs of an education program have been estimated. The assumptions of the estimate are that (1) a person would work part time ($4,000/year) in the regional planning agency office (Southern Tier East Regional Planning Board), (2) a mailing would be made once a year (40 cents/per household including postage) to every household (say 75,000 households) with education materials, (3) for secondary and nitrification alternatives, the program would last 5 years, and (4) because more complex devices are useful for AWT alternatives, the program would extend 5 years beyond 1985 (13 years altogether). The part time manager of the program would also have to answer questions directed to him from homeowners.

For the secondary and nitrification alternatives, the total present worth of the 5 years program would be about $143,000 for an average annual cost of about $34,000 at 6 1/8% interest rate. Because of the greater complexity of the program for the AWT alternative, the total present worth

of the 13 year program would be about $299,000 for the same average annual cost of about $34,000 at a 6 1/8% interest rate.

The relative amount of the education costs are quite small. In terms of direct expenditures, the more the nonstructural alternative is achieved, the less expensive a given technical alternative becomes. In other words, analysis showed (Plan Formulation Appendix) that millions of dollars could be saved at the STP's if flows were reduced by inexpensive nonstructural programs such as education about water conservation.

An Example of an Education Program

An educational and public use restriction program was implemented in New York City during the 1960's drought. Table VII-7 shows the yearly consumption of New York City during the 1960's, and the percent reduction from the previous year. The large reduction in 1965 the result of an educational campaign and use restrictions. The use restrictions were reported to have had minimal effect, but major reductions resulted from the educational program:

"The appeal to the public was undoubtedly the most important part of the campaign, for without their voluntary cooperation, the campaign would falter. Although restrictions were imposed on water usage, this type of restriction is difficult to enforce in a City the size of New York. The success of the campaign depended on the public's voluntary cooperation." (Temporary State Commission on the Water Supply Needs of Southeastern New York. "Measures to Reduce Water Consumption in Southeastern New York" (1973), quoting the New York City 1965 Annual Report of the Bureau of Water Supply.)

The reductions from education were effective only with domestic users as is indicated in Table VII-8. When the drought was over, and the education program ceased, demand returned to normal levels, and, in fact, exceeded previous consumption.

The New York experience has some application the Binghamton region, particularly in reference to these items:

1. Achievement of the nonstructural alternative beyond pricing must be achieved solely in the residential sector;

TABLE VII-7

AVERAGE TOTAL DAILY CONSUMPTION
NEW YORK CITY

	MGD	Percent Change From Previous Years
1960	1147.3	-0.4
1961	1167.2	+1.7
1962	1151.0	-1.4
1963	1158.8	+0.7
1964	1131.0	-2.4
1965	994.0	-12.1
1966	987.3	-0.7
1967	1078.3	+9.2

TABLE VII-8

AVERAGE NON-INDUSTRIAL AND INDUSTRIAL WATER CONSUMPTION

DURING THE DROUGHTS IN NEW YORK CITY

Year	Non-Industrial gpcd	Non-Industrial Percent Change From Previous Years	Industrial MGD	Industrial Percent Change From Previous Years
1960	118	+3.5	281.6	+4.3
1961	119	+0.8	289.4	+0.1
1962	118	-0.8	279.5	-1.7
1963	118	0.0	284.9	+1.9
1964	114	-3.4	280.4	-1.6
1965	97	-14.9	281.0	+0.2
1966	95	-2.1	282.7	+0.6
1967	110	+15.8	253.0	-10.5

2. Reductions below individually economic levels must be accompanied by a major, continuous education campaign, and

3. If the education campaign for non-economic personal reductions is not continuous, demand will rise to meet historic trends.

Social Impacts of the Education Program

An attempt was made to quantify the social impacts of the major education program. Referring again to Figure VII-2, one can see that an intensive the education program could convince the population of an area to reduce their water consmption below what they are willing to pay for. The reduction may come about by taking shorter showers, and spending more time to wash dishes by hand with less water. The direct monetary value of the reduced satisfaction of the population is then estimated to be the price of water which the population is willing to pay times the reduction in demand below the normal demand curve. This actually understates the social impact because the "consumer surplus" impact is not measured, only the market value of the water and sewer service taken.

The costs associated with the nonstructural alternative can be quite significant. The monetary valuation of the direct social impacts of a person using less water than he considers economically desirable means reduced expenditures at the treatment plant.

There are, of course, other beneficial impacts of achieving the nonstructural alternatives besides the reduction of direct costs at the treatment plant which should be considered. These impacts are basically those associated with the conservation of resources to treat wastewater. The resources are those which produce the materials to build structures and operate the plants, and energy is one of these.

Another important impact of the nonstructural alternatives is that of water supply prices. The Binghamton City Water Department, for example, has a supply capacity in excess of any predicted demand and a fixed distribution and transmission system in need of little extension. Therefore, major reductions in demand will result in price increases to cover the fixed costs (other than material-related operation costs). The price increase would reduce consumption beyond the original projections.

COST EFFECTIVE FLOW REDUCTION DEVICES FOR THE HOME

A variety of fixtures are available which can significantly reduce domestic discharges to sanitary sewers. The fixtures which are considered in this section are: (1) faucet aeration, (2) flow control devices for shower, washing machine and lavatory sink, and (3) special types of toilets or toilet adaptations.

The various devices are summarized in Table VII-9. Total installation costs per device and cost per capita are shown. The installation costs include material and labor. The water savings are shown in gallons/capita/day and 1000 gallons/capita/year, which, of course, vary with the planning period because of the predicted increase in per capita flow.

Descriptions of the Measures

A device which is in common use in some areas is the faucet aerator. The aerator, which mixes air with the water, is intended primarily as a splash device. The aerated water is a more efficient rinser and provides the water user with the impression that more water is coming from a tap than is actually present. Aerators are inexpensive devices to buy (about $2.00) and relatively easy to install (no plumber needed) if a faucet is constructed to accept the device. The useful life of the aerator has been estimated to be 15 years although such items may need replacement more frequently, depending on the nature of use and the quality of the water. Modest savings of approximately 0.5 gpcd, in addition to water heating reductions, are obtainable with aerators.

Flow reduction devices for shower heads limit the water rate obtainable for showers from 5 to 15 gpm to about 3 gpm. Large savings in water heating costs, in addition to the water, are also obtainable. A device which is often considered in conjunction with a flow limiter is a thermostatic mixing valve. The mixing valve is primarily used for convenience to the user by automatically adjusting proportions of hot and cold water. Thus, small water savings are available from the avoidance of water use for the sake of temperature adjustment. Similar devices, limiting flow valve and thermostatic mixing valve, are also available for lavatory sinks.

TABLE VII-9

REDUCTION DEVICE COSTS AND EFFECTS

Hardware Device	Total Installation Costs	Water Saving (gpcd) (1000 gal/yr) 1973	1977	1997
Aerator	$ 2.00	.5 .18	.5 .18	.5 .18
Dual Cycle Water Closet	$ 130.00	16.3 5.9	17.5 6.4	19.2 7.0
Limiting Flow Valve for Shower	$ 50.00	5.8 2.1	6.0 2.2	6.6 2.4
Batch Type Flush Valves in Dual Cycle	$ 158.00	14.4 5.3	15.5 5.7	17.0 6.2
Vacuum Flush Toilet (for 100 Units)	$ 295.00	20.9 7.6	22.5 8.2	24.8 9.1
Recycle Toilets	$ 325.00 ($3.65 O&M)	24.0 8.8	25.0 9.1	28.0 10.0
Batch Type Flush Valve for Water Closet	$ 105.00	7.0 2.3	7.5 2.7	8.2 3.0
Shallow Trap Water Closet	$ 110.00	7.2 2.6	7.5 2.7	8.2 3.0
Urinal with Batch Type Flush Valve	$ 175.00	6.5 2.4	7.0 2.6	7.7 2.8
Washing Machine w/Control Lever	$ 35.00	0.8 0.3	1.2 0.4	2.2 0.8
Vacuum Flush Toilets (for Single Home)	$1,520.00	20.9 7.6	22.5 8.2	24.8 9.1
Limiting Flow Valves for Lavatory	$ 68.00	0.5	0.5	0.6

Istallation costs and effects (based originally on 65 gpcd) after Bailey et al, "A Study of Flow Reduction and Treatment of Wastewater for Households" (1969).

The standard water closets in common use in the United States are notoriously inefficient water users. The common 4 gallon tank will discharge an additional 2 gallons to its contents for every flush for a total 6 gallon flush. Bricks and plastic bottles can be inserted into the tanks of water closets in order to lower the tank storage and thereby reduce the volume of water discharged during a flush. There is no cost associated with such a practice, although the indiscriminate installation of bricks may damage ceramic tanks. A two-quart displacement in the toilet could save 10 gallons per day for a family of four. Too much displacement, however, will reduce flushing efficiency and thereby result in possible unsanitary conditions, or the necessity of dual flushing. Commercially available tank volume reducers are also available. Float arms can be bent downward to reduce tank volume; however, this practice is not always recommended because of the pressure change will reduce flushing force.

In Great Britain, a dual flush toilet which provides two separate flush cycles, one for liquid wastes (1 1/4 gallons/ flush) and one for solid wastes (2 1/2 gallons/flush), is used. Considerable savings in water use can be obtained from the use of such devices. However, the dual flush toilet is only in common use in Great Britain, and, therefore, would require special importation arrangements.

Shallow trap toilets are also widely available in the United States. Although they cost about the same as the dual flush devices, the reduction in water use is less than half with the shallow trap than with the dual cycle. Shallow trap toilets appear and function much the same as conventional toilets.

Vacuum toilets use air rather than water to transport toilet wastes and require only 1/2 gallon per flush. Wastes are sent to a vacuum receiving tank (controlled by vacuum pump) for later discharge to sewer lines. The system, reportedly in use in Sweden and the Carribbean, is quite expensive, and has been found practicaly only in large developments such as motels and apartment houses.

Batch flush toilets are already in use in many commercial and apartment buildings in the United States. Instead of a tank storing water for a sudden discharge to flush wastes, a pressurized stream of water comes directly from a water pipe. The toilet requires at least a one-inch water line which is generally greater than commonly found in most homes. One must expect, therefore, some routing of new

water lines for installation. The water discharge depends on the pressure available and varies from 1/2 to 4 gallons per flush.

Other more exotic toilets are marketed. One, a completely dry toilet called the "Ecolet," which is an aerobic digestor, has been found to be most applicable in remote areas developed with summer and weekend homes. The device requires a continuous supply of electricity.

Recycle toilets, which are actually conventional toilets, reuse screened water from washing and showers. Besides certain aesthetic consequences from that approach, considerable plumbing modifications must be made to the home.

Urinals use only 1.5 gallons per flush, and, therefore, have applicability in households where extra bathroom space (and males enough to justify the device) are present. Currently, the economics of using such devices is only justified in commercial buildings.

Much of the future increase in domestic demand is a result of laundry use. Level controls for reducing water consumption for partial loads are available and are considered in this analysis as devices which should be seriously considered for installation. However, the overall water saving of the level controls is only on the order of 5 gallons per day for a family of four. The variation among different washers is 20 to 33 gallons per cycle.

Cost Effectiveness of the Measures

Various studies have as those by Bailey and Sharpe have shown many of the above devices to be cost effective, particularly when the combined rate for water and sewage treatment is over $1.00/1000 gallons. However, the use of water-saving devices is not widespread. The water-saving toilets account for less than 5 percent of installed toilets nationwide.

The reason for this lack of acceptance must then be some combination of ignorance concerning the availability of the devices, apathy regarding the savings obtainable, aesthetic appeal of the devices, and a difference in economic evaluation techniques between the homeowner and the researchers who have heretofore recommended the devices. This section addresses the latter issue.

Primarily, a homeowner may not be willing to invest $100 for a new toilet if he were told that he could recover his costs in only 15 years, and if he did not consider interest costs.

Figures VII-3 and VII-4 demonstrate the number of years necessary to recover costs from reduced water, sewer, and heating bills by installing a water-saving device versus the combined (incremental) cost of water and sewer. The curves are created for the non-urban households (single family detached). Figure VII-3 is constructed with no interest rate (i = 0 percent) and Figure VII-4 is constructed with an interest rate of 10 percent.

Since the water consumption patterns are different from year to year, Figure VII-3 shows the decline in cost recovery time from decade to decade for all the devices. Figure VII-4 only shows this change for the washing maching control lever because laundry use is the water demand projected to increase the most significantly over the next 30 years.

The curves that intersect the vertical axis represent those devices which save on water heating. The use of interest rates expectedly lengthens the period over which a homeowner must recover his costs. The curves are useful in predicting what new devices might become desirable, given a price change for sewage treatment from implementing an advanced waste treatment plan.

Tables VII-10 and VII-11 attempt to demonstrate those devices which would be likely to be installed under secondary treatment and biological advanced waste treatment scenarios, with an education program to inform people of the effectiveness of the devices. The presentation is made for different payback periods in order to investigate user sensitivity.

For the case of secondary treatment, only aerators, shower controls, and a plastic bottle are cost effective from the homeowner's viewpoint, given that he recovers his capital for home improvements without interest over 4 years.

The aerator and shower control are economical only because of the energy savings, and the plastic bottle is economical only because it is free.

When the recovery period is extended to 10 years, the homeowner can be induced to make much more drastic changes to his plumbing. Washing machine controls are economically

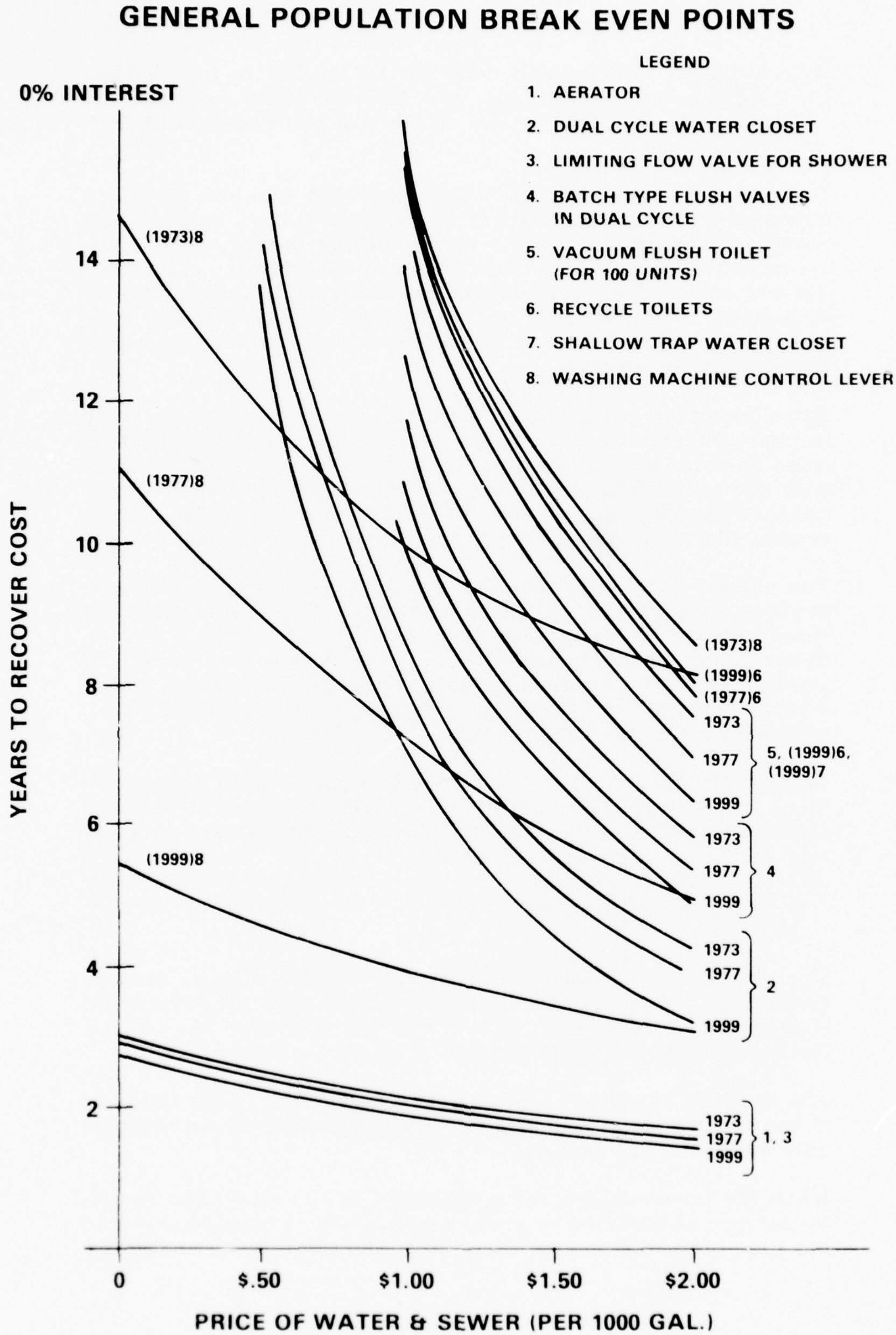

GENERAL POPULATION BREAK EVEN POINTS
0% INTEREST
LEGEND
1. AERATOR
2. DUAL CYCLE WATER CLOSET
3. LIMITING FLOW VALVE FOR SHOWER
4. BATCH TYPE FLUSH VALVES IN DUAL CYCLE
5. VACUUM FLUSH TOILET (FOR 100 UNITS)
6. RECYCLE TOILETS
7. SHALLOW TRAP WATER CLOSET
8. WASHING MACHINE CONTROL LEVER
YEARS TO RECOVER COST
14
12
10
8
6
4
2
(1973)8
(1977)8
(1999)8
(1973)8
(1999)6
(1977)6
1973
1977
1999
5, (1999)6, (1999)7
1973
1977
1999
4
1973
1977
1999
2
1973
1977
1999
1, 3
0
$.50
$1.00
$1.50
$2.00
PRICE OF WATER & SEWER (PER 1000 GAL.)

FIGURE VII-3

GENERAL POPULATION BREAK EVEN POINTS

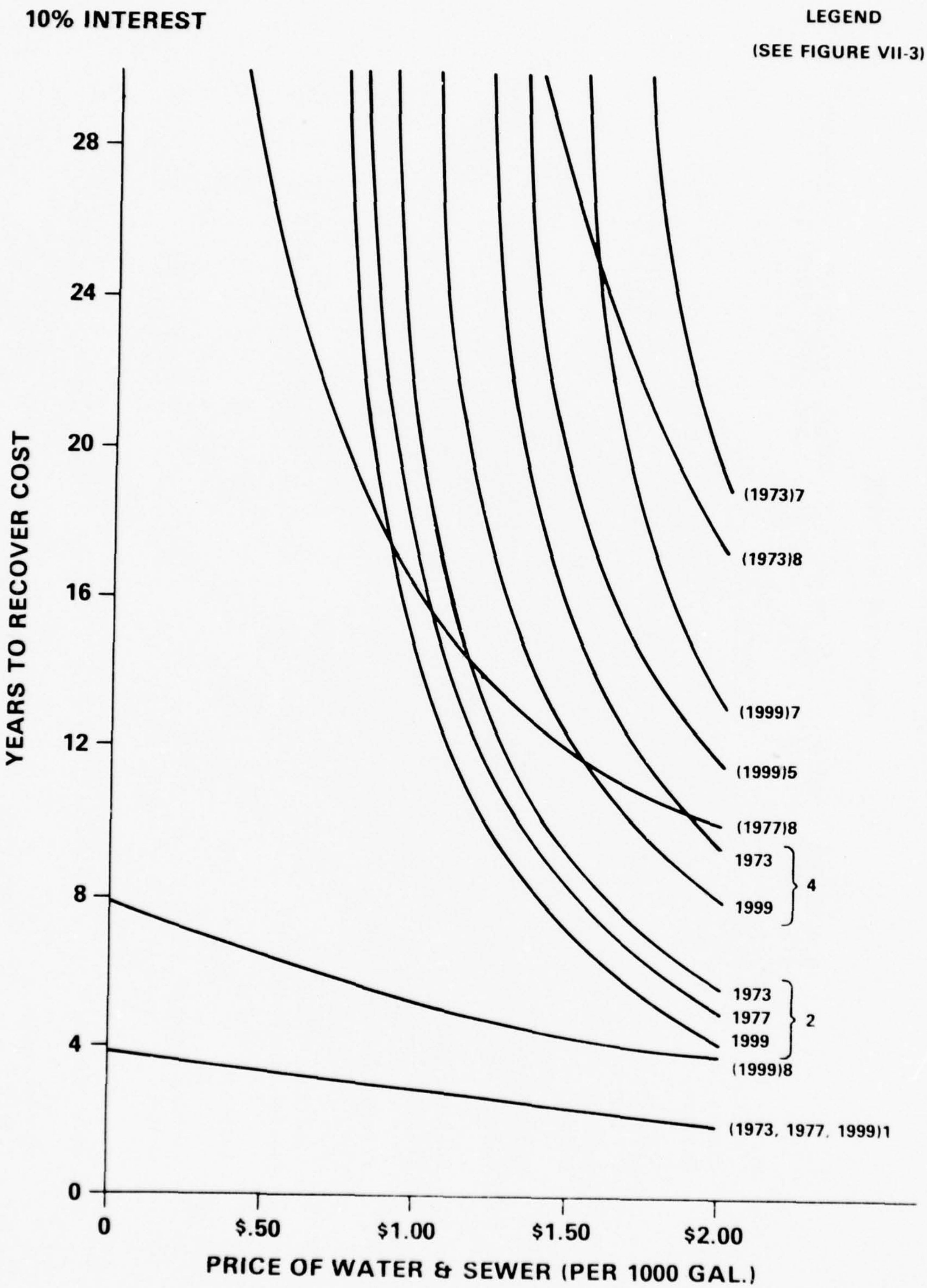


FIGURE VII-4

TABLE VII- 10

DEVICES WHICH CAN BE READILY ENCOURAGED

SECONDARY TREATMENT

	Binghamton		Endicott		Chenango		E. Owego		W. Owego		O. Village	
	1977	1999	1977	1999	1977	1999	1977	1999	1977	1999	1977	1999
4 Years												
Limiting Flow Valves for Showers	X	X	X	X	X	X	X	X	X	X	X	X
Aerators	X	X	X	X	X	X	X	X	X	X	X	X
Washing Machine Control	-	-	-	-	-	-	-	-	-	-	-	-
Dual Cycle Water Closet	-	-	-	-	-	-	-	-	-	-	-	-
Shallow Trap Toilet	-	-	-	-	-	-	-	-	-	-	-	-
Plastic Bottle	X	X	X	X	X	X	X	X	X	X	X	X
10 Years												
Limiting Flow Valves for Showers	X	X	X	X	X	X	X	X	X	X	X	X
Aerators	X	X	X	X	X	X	X	X	X	X	X	X
Washing Machine Control	X	X	X	X	X	X	X	X	X	X	X	X
Dual Cycle Water Closet	-	X	-	-	-	-	X	X	X	X	X	X
Shallow Trap Toilet	-	-	-	-	-	-	-	-	-	-	-	-
Plastic Bottle	X	-	X	X	X	X	-	-	-	-	-	-

TABLE VII- 11

DEVICES WHICH CAN BE READILY ENCOURAGED

BIO AWT

	Binghamton 1999	Endicott 1999	Chenango 1999	E. Owego 1999	W. Owego 1999	O. Village 1999
		4 Years				
Limiting Flow Valves for Showers	X	X	X	X	X	X
Aerators	X	X	X	X	X	X
Dual Cycle Water Closet	-	-	-	-	-	-
Washing Machine Control	X	-	-	X	X	X
Plastic Bottle	X	X	X	X	X	X
100 Unit Vacuum Flush	-	-	-	-	-	-
		10 Years				
Limiting Flow Valves for Showers	X	X	X	X	X	X
Aerators	X	X	X	X	X	X
Dual Cycle Water Closet	X	-	-	-	-	-
Shallow Trap Toilet	-	X	X	-	-	-
Washing Maching Control	X	X	X	X	X	X
Plastic Bottle	-	-	-	-	-	-
100 Unit Vacuum Flush	-	-	-	X	X	X

useful in this case, and, where the water/sewer rates are high, installation of a new dual flush toilet becomes justifiable.

The installation of devices is more widespread with the AWT plan. Vacuum flush toilets could be economically installed for large developments in Owego Town if a 10 year write-off and no interest were assumed. In addition, shallow trap toilets become useful if dual flush toilets are not available.

Summary

1. In general, the devices which would be uniformly cost effective for the secondary treatment scenario are aerators, flow controls for showers, and plastic bottles to displace water in a conventional water closet tank. In 1977, the savings would be 9.0 gpcd, and in 1999, the savings would be 9.6 gpcd.

2. The nitrification strategy does not significantly alter the selection of the devices.

3. The AWT alternatives would justify a general acceptance of aerators, flow controls for showers, washing machine control levers, and dual cycle toilets. The 1999 savings would be 10.7 gpcd.

OTHER MEASURES

There are other measures which can achieve a nonstructural reduction of wastewater flow. Such measures include zoning and building codes, and industrial surcharges.

Zoning & Building Codes

Building codes often specify minimum standards for plumbing fixtures. For example, toilets should have a minimum flush. Locally, particularly in the suburban growth areas, the building codes should be modified to include the following requirements: (1) maximum flush for toilets; (2) aerators on all faucets, other than garden or other special use

fixtures; and, (3) limiting flow shower heads. Furthermore, strict enforcement of various sewer use ordinances regulating connection and discharge to municipal systems by illegal users should help to reduce wastewater flows to the sewage treatment plants.

Industrial Surcharges

Industrial surcharges can have a large impact in reducing not only the volumetric flow but also the pollutant loading to a treatment plant. As part of the conditions of the NPDES permits, the municipalities must survey industries in their service areas in order to inventory the volume of pollutants emanating from each plant to the sewer system. Since this information has not been generated yet, the analyses of non-structural alternatives can only generally discuss this measure.

A surcharge is a fee levied against a discharger whose wastes are stronger than a given maximum amount. The maximum allowable concentration may be defined in terms of domestic strength or the plant average. The parameters of the levy are those beyond average volumetric flow which influence the cost of building and operating a treatment plant: BOD, suspended solids, and peak volumetric flow.

Essentially, an increase in surcharge would result in increased pretreatment at an industry to the point where the costs of further increased pretreatment per pound of pollutant would be equal to the surcharge (in dollars) per pound of pollutant. The reduction in pollutant discharge would result in a decrease in the cost of additional water (which would tend to increase demand) and would result in a shift to a new demand curve as a result of a reduced need for water to carry wastes.

CHAPTER VIII

CULTURAL RESOURCES RECONNAISSANCE

As an agency of the Federal Government, the Corps of Engineers had certain responsibilities for insuring an adequate consideration of cultural resources' protection and preservation during the Binghamton Wastewater Management Study. Section 1 (3) of Executive Order 11593 (Protection and Enhancement of the Cultural Environment) stresses this responsibility: "The Federal Government shall provide leadership in preserving, restoring, and maintaining the historic and cultural environment of the Nation."

For the purposes of this report, a cultural resource was defined as "any building, site, district, structure, object, data, or other material significant in history, archeology, or culture." Because the wastewater management study for Broome and Tioga Counties produced a report of survey scope detail, a "cultural resources reconnaissance" provided the appropriate level of investigation. A cultural resources reconnaissance was defined as a "literature search and records review plus an on-the-ground surface examination of selection portions of the area to be affected, adequate to assess the general nature of the resources probably present, and the probable impact of a project. Test excavations may be required at some sites so that evaluations may be adequately accomplished."

The primary purposes of the cultural resources reconnaissance were five-fold: (1) to determine known cultural resources; (2) to investigate possibilities of undocumented or undiscovered cultural resources; (3) to field examine selected portions of the resources; (4) to assess the nature and extent of impacts on these resources to be expected as a result of various projects; and (5) to discuss the methods and anticipated costs for the detailed "cultural resources survey" to be accomplished during the actual planning stage for a specific project.

In order to accomplish these tasks, the Baltimore District, U. S. Army Corps of Engineers contracted with Dr. Frederick Plog of State University of New York at Binghamton for a cultural resources reconnaissance. Dr. Plog's report is presented in the following sections.

CULTURAL RESOURCES RECONNAISSANCE

BINGHAMTON WASTEWATER MANAGEMENT STUDY

BROOME AND TIOGA COUNTIES, NEW YORK

David Stong

Fred Plog

Department of Anthropology

State University of New York

Binghamton, New York

Final Report

During the early summer of 1975, the U. S. Army Corps of Engineers contacted the Department of Anthropology of the State University of New York, Binghamton, concerning a cultural resources reconnaissance to accompany the Binghamton Wastewater Management Study, Broome and Tioga Counties, New York. Over the course of the summer, the goals of such a study were narrowed and refined and the federal contract procedures implemented. In late September, a contract was let for this cultural resources reconnaissance. The reconnaissance was done during October 1975 by a team of archeologists from the Department of Anthropology, State University of New York, Binghamton. This report describes the nature of the study that was conducted and its results.

SCOPE OF WORK

Five major work tasks to be completed in the course of the study were defined by the U. S. Army Corps of Engineers and agreed to by the Department of Anthropology, State University of New York, Binghamton. They included:

(1) Conducting a literature and documentary search to identify the location of historic and prehistoric sites in Broome and Tioga counties.

(2) Conducting a surface reconnaissance by driving and/or walking 4.6 miles of proposed sewer interceptor route and a total of twenty acres of sewage treatment plant and storm overflow site locations.

(3) Conducting a sample reconnaissance of approximately 15 per cent of the direct effect areas in order to identify locations where there are high concentrations of prehistoric and historic sites and properties.

(4) Providing a list of those sites having cultural significance and assessing the general significance or values of resources located in the project alternative areas.

(5) Proposing procedures and estimating costs for a cultural resources survey of the project area and for any required preservation and/or mitigation.

LITERATURE SEARCH : HISTORIC SITES

There are currently a number of historic sites in Broome and Tioga counties on the National Register of Historic Places. The sites are listed in Appendix 1. However, the list provides only a limited perspective on the historical resources of the area.

The historic record of Broome and Tioga counties is an extremely rich one. But, the published literature on the history of the area is both limited and redundant. Wilkinson's Annals of Binghamton (1840), Smith's History of Broome County (1885), Lawyer's Binghamton, Its Settlement Growth and Development (1900), Seward's Binghamton and Broome County, New York (1925), Kingman's Our Country and Its People (1892), and Montillon's Historic Architecture of Broome County, New York and Vicinity (1972) were the principal references used in attempting to characterize this record.

Broome and Tioga counties were first settled immediately following the Revolutionary War, Broome County in 1785 and Tioga County in about 1787. The first production facilities, grist mills, were built in 1788 in Broome County and 1793 in Tioga County. The first churches in the two counties were built in the early 1790's. Binghamton's first school was built in 1790-91. The first school built in what is now Tioga County was erected in about 1814. (Tioga County originally included what are now Chemung and Broome Counties and portions of Chenango County. What is now Tioga County was initially a somewhat marginal portion of the county). The first public governmental buildings were built in 1793 in Broome County and in 1823 in what is now Tioga County. The first turnpikes in the two counties were built in 1806. A canal linking the Susquehanna River to the Erie Canal was completed in 1837. Subsequently, a canal was built along the Susquehanna River toward Owego, but was never completed.

Demographic information on the two counties is sketchy. However, the population of Broome County was at least 300 in 1812, 2000 in 1840, 4000 in 1850, 44,000 in 1870 and 113,000 in 1920. The population of Tioga County was about 1000 in 1790, 25,000 in 1850, 33,000 in 1875 and 30,000 in 1890.

These data suggest the impossibility of comprehensively inventorying historic sites in the two counties area. Defining a historic site as any site older than fifty years, the problem is evident--close to a majority if not a majority of the standing structures in the two county area are historic sites or are likely to have been erected on the remains of historic sites. Put in a different way, in 1925, 50 years ago, there were approximately 150,000 people living in the area, occupying, erecting, working, living and learning in historic structures. Montillon's (1972) architectural study of Broome and adjacent areas of Tioga County lists nearly 200 standing structures that reflect the distinctive architectural styles in the areas history: Federal (1800-1830), Classic Revival

(1825-1850), Gothic Revival (1845-1860), Innovative (1860's and 1870's), American Baroque and Queen Anne (1870's) and Romanesque (1890's). The 1917 Rural Directory for the area lists the following manufacturing activities that are distinctive of this period and no longer exist: anchors, art glass, blacksmith, bottles, brewing, bricks, buttons, cigars, chewing gum, chemicas, crockery, china, organs and silk.

It is of course not the case that each and every one of these loci would qualify for the National Register of Historic Places. However, there are at least 10,000 standing structures in the two county area that might qualify and a sample of them might justifiably be preserved on the basis of one or more of the Register's criteria of significance. This estimate does not include buried and/or partially buried sites such as canals, grist mills, and saw mills.

Thus, Broome and Tioga Counties are essentially historic zones. There is a probability that any anticipated project may affect a building or a site that meets National Register significance criteria. A detailed assessment of any project area to determine if standing or buried historic sites might be adversely impacted is essential.

LITERATURE SEARCH : PREHISTORIC SITES

Nearly 200 prehistoric sites are recorded in the available archeological literature (Engelbrecht 1970; Parker 1922; Ritchie 1944, 1957, 1969) and local site files. However, any generalizations about the location of prehistoric sites or the prehistory of the area are likely to be misleading. (1) There is undoubtedly duplication between the various records owing to poor descriptions of locations. (2) Some of the sites listed have been destroyed since the dates when their locations were recorded. For example, many of the sites listed by Engelbrecht (1970) and the files of the Department of Anthropology, State University of New York, Binghamton, were recorded in conjunction with highway salvage work. Subsequently, the sites were destroyed as the highway was constructed. (3) No systematic survey of prehistoric site locations has ever been undertaken in either Broome or Tioga Counties. Survey efforts have generally been casual. Intensive efforts are restricted to highway rights of way, sewer and reservoir projects in only a few loci. (4) The occurrence of

around 200 archeological sites in an area of roughly 10,000 square miles does not reflect a high density of sites (.2/ mi^2). Densities ranging up to 100/mi^2 have been recorded in other areas of the country. At present, there is no way of evaluating the validity of the known density for Broome and Tioga counties. The densities may be higher. On the other hand, these might be most or all of the prehistoric sites in the area.

Nevertheless, we can conclude that:

(1) There are substantial cultural resources in the area suggesting that there is some probability that any construction project might adversely impact these resources.

(2) Prehistoric occupation of the area began early (Paleo-Indian period) and continued up to contact times.

(3) Most known sites occur on or near the floodplains of major drainages.

These cultural resources reflect the changing utilization of the area by successive populations beginning perhaps as early as 10,000 years ago. As in most areas of the country the record of Paleo-Indian hunters is a limited one. The paucity of evidence concerning these groups makes every shred of remaining evidence all the more important.

For most of the prehistoric period, the area was inhabited by "Archaic" hunter-gatherers who lived in small bands. The variation in site size in the area suggests seasonal variation in their subsistence and settlement patterns. There appear to be large village and small camp sites suggesting that small microbands coalesced during some season(s) of the year, most probably spring. Because sites seem to be heavily concentrated along major streams and rivers, a focus on the exploitation of riverine resources seems probable.

The literature on temperate zone hunting-gathering bands is extremely limited. Few such groups were left in this zone by historic times anywhere in the world. Thus, neither the ethnographic nor the archeological data on such groups is substantial. For this reason, the archeological record for the Archaic Period in New York State offers a substantial opportunity for understanding a poorly known adaptive strategy.

"Woodland" groups were the next to inhabit the area, beginning a few centuries before or after the time of Christ. At some point in the vicinity of A.D. 1000 these groups began to practice corn agriculture and to adopt a sedentary lifestyle. The reasons for this important change in subsistence and settlement are currently unknown.

Again, this summary is a very general one precisely because of the limited amount of archeological work that has been done in the areas. Even in these paragraphs there is much speculation; to go further would be worse than speculation. To address any of the questions raised above will necessitate preserving the limited quantity of remaining evidence.

SURFACE RECONNAISSANCE

A surface reconnaissance of the proposed locations of the project facilities was conducted by a team of 3 archeologists. All of the areas that would be impacted by the alternatives being considered were systematically covered. It must, however, be understood that, due to the initial level of study, the maps provided by the U. S. Army Corps of Engineers are highly general maps showing only the approximate location of the alternatives, this reconnaissance was of the general area of the possible construction and does not necessarily correspond to the exact location of the possible construction (No complaint against the Corps is intended by this statement, the intention is simply to note the generality of the maps for future studies).

Surveying in areas such as Broome and Tioga counties is not a very effective archeological tool. The vegetation cover is very heavy, limiting the extent of exposed ground surface. Moreover, the high level of geomorphic activity in the area tends to bury sites of even minimal antiquity in a short period of time. Test pits dug by the Department of Anthropology, State University of New York, Binghamton on other resource assessment projects, for example, have identified materials as young as 10 to 20 years at depths of over 50 centimeters. Therefore, except in disturbed areas, the probability of identifying prehistoric or older historic sites on the basis of surface evidence is very low.

Two very valuable pieces of information may, however, be obtained from such a reconnaissance. Any standing historic structure will be evident. And, the integrity of the ground surface itself can be evaluated--the extent to which recent disturbances may have destroyed or buried any prehistoric or historic sites can be determined. Moreover, a reconnaissance provides an opportunity for discussing with local landowners and residents the nature of any first hand knowledge they may have of historic or prehistoric remains.

Proceeding alternative by alternative, the results of the survey were as follows:

(1) Overflow Site 2. Overflow Site 2 lies largely on an undisturbed segment of the floodplain of the Susquehanna River. Only a small area of the site near the river shows any evidence of disturbance. This location is one in which the probability of a prehistoric site existing is high. There is no evidence of a standing historic site in the project area.

(2) Overflow Site 4. This site lies on a somewhat disturbed segment of the floodplain of the Susquehanna River adjacent to the Temple Concord. A prehistoric site was excavated adjacent to this location during the construction of a parking lot at the Temple Concord (Hayes, 1968). Thus, the probability of finding additional evidence of prehistoric cultural activity in this location is quite high. No standing historic structure was seen at this location.

(3) Overflow Site 8. Overflow Site 8 lies on a highly disturbed segment of the floodplain of the Chenango River. This disturbance is of sufficient magnitude that any prehistoric site on the location would probably have been destroyed. There is evidence, however, of standing historic structures at this location.

(4) Overflow Site 11. Overflow Site 11 lies on a highly disturbed segment of the floodplain of the Susquehanna River. This location has been excavated and refilled to a substantial depth. No evidence of historic or prehistoric sites were found at this location. It is improbable, given the degree of such disturbance, that any such materials could be found.

(5) Overflow Site 15. Overflow Site 15 lies on a highly disturbed segment of the floodplain of the Susquehanna River. The property, belonging to Columbia Gas of New York, has been long used as a location for gas tanks. The construction of gas tank foundations has comprehensively disturbed this area. No evidence of historic or prehistoric sites was found. It is highly improbable given the magnitude of the disturbance that any such materials could be found.

(6) Chenango Valley Sewage Treatment Plant. This location is adjacent to the floodplain of the Chenango River across from Broome Community College. No evidence of historic or prehistoric sites was observed during the walking survey at this location. Nevertheless, the location is one in which the probability of a sub-surface historic or prehistoric site being located is high. Moreover, there is no evidence of disturbance of the sediments at this location.

(7) Chenango Valley Sewer Line. This line runs through the floodplain of the Chenango River and adjacent areas between the proposed location of the Chenango Valley Sewage Treatment Plant and a location to the south of the Bevier Street Bridge. There is substantial disturbance in some of the areas that could be affected by a possible project. Borrow has been taken from the area of the proposed River Front Park to the north of the Bevier Street Bridge. The banks of the Chenango River to the south of the Bridge have been heavily riprapped. There are also undisturbed areas. Evidence of prehistoric activity was found on the walking reconnaissance. Nine chipped stone flakes, all chert, and the tip of a projectile point (too small to date) were found in the area of the U. S. Department of Agriculture building. Moreover, the sewer line would pass through or adjacent to the prehistoric-historic site of Otsiningo. No standing historic structures were observed in the survey area.

(8) Owego Sewer Line. The Owego Sewer line would be built on the floodplain and adjacent areas of the Susquehanna River in the vicinity of Owego, New York. No historic or prehistoric materials were located on the walking survey of the route of the sewer line. Nevertheless, informants indicated that prehistoric cultural materials had been found in gardens adjacent to the proposed construction area. A portion of this line would be built underneath Front Street in Owego. A walking survey can, necessarily, provide no information concerning the materials lying underneath the street. However, when there is evidence of materials adjacent to the street, the probability that similar materials, perhaps undisturbed, would be found under the street is quite high.

(9) Summary. In areas of heavy surface vegetation, the evidence of prehistoric cultural activity that can be found on a walking reconnaissance is limited. Nevertheless, in this instance, evidence of historic and/or prehistoric cultural activity was found in the cases of Overflow Sites 2, 4, 8, the Chenango Valley and the Owego sewer lines. These data are of great utility in planning future work and were used in planning the more detailed reconnaissance of the locations in question, the project task that we will now discuss.

TEST EXCAVATIONS

On the basis of the surface reconnaissance of the alternative construction areas, test excavations were planned. The basic strategy employed involved digging shovel test pits to a depth of 75 cm. Locations where such test pits were dug are indicated on the project map. The need for these test pits was mentioned earlier--

in an area where the cover of surface vegetation is substantial, remains lying immediately below the surface are unlikely to be evident on the surface. Test pits were located at intervals adequate to provide evidence of the general nature of the subsurface remains in the area, not the location of every site of cultural activity. The precise strategy used will be discussed on an alternative by alternative basis.

(1) Overflow Site 2. A total of 22 test pits were dug at this location. The pits were arrayed in 2 parallel lines and placed at 10 meter intervals. Additionally, a surface collection was made of a garden area and the surface of the site was examined in more detail. Two of the pits yielded chipped nodules of flint and one yielded a small flake. The surface collection produced a single flaked flint nodule, and a square nail, ceramics, glass and tile (ca. 1875-1925). While the evidence is, at this point, minimal, historic and prehistoric cultural activities at this location are indicated and further study is required. Given that this location is on the active area of the floodplain, testing to a greater depth than is possible on a sample reconnaissance would be required.

(2) Overflow Site 4. Three test pits were excavated in this location at intervals of twenty meters.No additional pits were dug because all three yielded a concentrated mixture of glass, china and bricks indicative of fill material. Each pit yielded one chipped stone flake while one yielded a square shank nail dating to the last half of the 19th century. Moreover, the occurrence of predominantly historic materials in the upper strata of the test pits suggests that further prehistoric materials would be more deeply buried. Thus, additional assessment, including deep testing would be required at this location.

(3) Overflow Site 8. Historic materials at this location were noted on the surface reconnaissance. Additional testing was not undertaken because the degree of disturbance made such a procedure unjustifiable.

(4) Overflow Sites 11 and 15. The extensive disturbance at these locations made further testing unjustifiable.

(5) Chenango Valley Sewage Treatment Plant. A total of 22 test pits were dug at this location. Eight of these were located in an old river channel and 14 on the bank of this channel. Four test pits in the abandoned river channel showed possible evidence of prehistoric materials, flint. Five of the fourteen test pits on the old river bank yielded chipped stone flakes, 4 to 6 flakes in each

of the pits. These pits occur in an area along the southern edge of the old loop. Thus, there is substantial evidence of prehistoric cultural activity at this location that would require further assessment.

(6) Chenango Valley Sewer Line. Twenty-four test pits were dug in two locations along this line. Seven test pits were dug at 30 meter intervals along 2 parallel lines south of the Bevier Street Bridge. Four of these pits yielded a total of 9 pieces of chipped stone. Seventeen test pits were dug in the River Front Park at 30 meter intervals along a single line. No cultural materials were recovered from these pits. As noted earlier, prehistoric cultural materials have also been recovered from the Otsiningo Site lying just to the north of the Park. Further assessment of the sewer line would be needed.

(7) Owego Sewer Line. Only a portion of the proposed line was amenable to sample reconnaissance. As noted earlier, one segment of the line would be beneath the street. Another portion of the line is in a swampy area. Thirty-one test pits were dug at 40 meter intervals from the intersection of Broadway Street and the railroad along the north side of the railroad tracks. Eleven of these test pits, yielded prehistoric and historic cultural materials. Six pits contained chipped stone flakes; five contained late 19th century and early 20th century glass and ceramics. A surface collection made in a field yielded five chipped stone articles. Thus there are locations of prehistoric and historic cultural activity along this line that would require detailed assessment.

(8) Summary. Evidence of prehistoric and historic cultural activity was found through sample reconnaissance in a variety of locations in areas to be impacted by the various alternatives. A detailed assessment of the impact of these alternatives on the cultural resources is required. Ultimately, funding for specific assessment would be required. At this time, a general assessment of significance is warranted.

ASSESSMENT OF SIGNIFICANCE

Any determination of the significance of prehistoric and historic cultural materials must be made in a context. The context includes the nature of the study that has been done of the cultural resources to be impacted by a specific project and the nature of previous studies that have been done of the general cultural resources of the area. Both of these sets of information have now

been discussed and a general assessment of significance can be made. As has been clearly indicated throughout this report, the cultural resource investigations undertaken to this point are of a preliminary and general nature. The U. S. Army Corps of Engineers has made clear its desire for no more than a general study at this stage in the planning process. Therefore, any conclusions reached on the basis of the work undertaken must pay particular attention to the limited evidence sought and obtained to date. We may summarize this evidence as follows:

(1) A search of documents and literature describing the history and prehistory of the area indicates that cultural resources of both varieties are present within the area in significant quantities. In the case of prehistoric sites in particular, the floodplain locations of the proposed projects were preferred locations of sites for prehistoric peoples, to the extent that we are able to understand their behavior at present.

(2) Evidence of prehistoric cultural activity was located on the ground surface during the walking survey.

(3) Evidence of historic and/or prehistoric cultural activity was recovered from a total of 28 of the 102 test pits dug as a part of the sample reconnaissance of the alternative construction areas.

In short, there is both direct and indirect evidence of historic and prehistoric cultural activity that would be directly impacted by the proposed alternatives. The direct evidence is the artifact locations actually recorded. The indirect evidence is derived from projections based on this sample. While the nature of the direct evidence is clear, the nature of the indirect evidence is less so, and some further explanation is warranted.

Prehistoric sites in the Broome-Tioga Counties area may be contained in an area as small as a few dozen square meters. Sample test pits placed in the manner allowed for the sample reconnaissance are intended to identify only a portion of these sites, but a portion that has been identified in such a way that generalizations can be made concerning evidence that is likely to be found in areas not actually tested. Thus, on the basis of the evidence obtained in the reconnaissance, one would predict that a minimum of 25 per cent of the alternative construction areas sampled is likely to contain prehistoric and/or historic cultural resources.

For example, subsurface testing could not be done under Front Street in Owego. But, the sample reconnaissance and informant interviews suggest that locations of prehistoric cultural activity are likely to be found there and that these would be impacted. Thus, given the data base available at present, one is forced to conclude that there may be substantial direct impacts beyond those specifically identified in this report.

Moreover, the report does not encompass all of the potential impacts of the project, specifically the indirect impacts. The scope of work under which the cultural resources reconnaissance was carried out did not include an assessment of sewer lines that would be constructed to bring waste to the Chenango Valley Sewage Treatment Plant or Binghamton-Johnson City Interceptor. These lines would be built in areas essentially similar to those that have been discussed and would pass through or adjacent to known locations of prehistoric sites.

All of this information leads to the conclusion that the impact of the alternatives on prehistoric and historic cultural resources may be substantial. Is the impact likely to be significant? This question can be answered by reference to the criteria for nominating sites for the National Register of Historic Places.

(1) Historical events. There is no evidence that any of the sites located to date are associated with events that made a significant contribution to the broad pattern of the area's history.

(2) Significant persons. There is no evidence that any of the sites located to date are associated with the lives of persons significant in our past.

(3) Distinctive characteristics. Pending a detailed assessment, it may be the case that the historic site at Overflow Site 8 is representative of a distinctive type or period of construction. There is no such evidence for any other alternative location.

(4) Information. There is substantial evidence that the sites located to date are likely to yield information important to our understanding of the history and prehistory of the area. This conclusion can be justified in the following manner:

(a) A limited amount of archeological activity has occurred in the Broome-Tioga Counties area.

(b) Most of the available information reflects limited excavation at a limited number of sites and non-systematic, non-intensive survey efforts.

TABLE 1 : CULTURAL RESOURCES RECONNAISSANCE SUMMARY TABLE

	Literature Search				Test Excavations		Further Evaluation Needed During Design Stage
	Prehistoric Sites in Area		Historic Sites in Area				
	National Register	Other	National Register	Other	Prehistoric Artifacts	Historic Artifacts	
Overflow Site 2	None	Possible	None	Possible	2 Stone Flakes	Nail, glass, ceramics, tile	Yes
Overflow Site 4	None	Possible	None	Possible	5 Stone Flakes	Nail	Yes
Overflow Site 8	None	None	None	Possible	None	Historic structures	Yes
Overflow Site 11	None	None	None	Possible	None	None	No
Overflow Site 15	None	None	None	Possible	None	None	No
Chenango Valley STP	None	Possible	None	Possible	34 Flakes	None	Yes
Chenango Valley Sewer Line	None	Possible	None	Possible	8 Flakes, possible implement	None	Yes
Owego Sewer Line	None	Possible	None	Possible	7 Stone Flakes	China, glass	Yes

(c) The bulk of the information that has been obtained was obtained while modern archeological field techniques were still in a developmental stage. As a result, the work poorly reflects the nature of the cultural materials that actually exist at these loci.

(d) As a result, no comprehensive understanding (or even a limited one) of the behavior of prehistoric populations that lived in this area during the last 10,000 years can be written.

(e) The information that could potentially be obtained from the sites discussed in this report as well as the other sites that would be impacted by a project would contribute significantly to such an understanding.

Because the precise design of these alternatives has not been completed, there is no way to precisely specify their impacts. There is no evidence that a site currently on the National Register of Historic Places will be adversely impacted by the possible construction. No historic or prehistoric sites described in the existing literature are clearly within the possible impact zone. Sites that appear to be within the possible impact zone were located through reconnaissance. One can say with assuredness that the project as presently conceived would have impacts on areas that are immediately adjacent to if not on sites of cultural activity. One can say that there would be indirect impacts that would also affect these resources. But, until the planning stage approaches a point where there are specific construction alternatives, a definitive evaluation of the impacts would be misleading. The only conclusion warranted at present is that it would be very difficult to construct any project on the floodplains of the Susquehanna and Chenango Rivers or that results in increased modern activity in these areas that would not have adverse impacts on significant historic and prehistoric cultural resources.

PRESERVATION, MITIGATION, RESEARCH DESIGN AND COSTS

The cultural resources reconnaissance has indicated that there are potentially significant prehistoric and historic cultural resources in the areas that may be impacted by the project. Therefore, we recommend a second phase archeological program of intensive survey, evaluation and when necessary recommendations for mitigation procedures to allay the project's potential environmental impacts.

The purpose of the various environmental protection acts passed in the last several years is to identify means whereby needed public facilities can be constructed without adversely impacting significant resources, in this instance

significant prehistoric and historic cultural resources. That the assessment activities carried out to date suggest a high probability of adverse impact on such resources is not in and of itself a problem, as long as the individuals and agencies responsible for the project and the individuals and agencies responsible for protecting the resources work effectively to meet their joint goal: designing a project that has no adverse impact on the resources. Thus preserving the resources is a primary goal from a conservationist perspective. Finding a feasible way of preserving the resources while meeting the public need is the goal of both the conservationist and the planner. In this regard, two questions are basic. Are there construction alternatives that would have a less adverse impact on significant cultural resources? Is there a way of designing the proposed project that would have no adverse impact on significant cultural resources?

Answering the first question is beyond the scope of this report. At the outset, there were forty proposed alternatives in the Binghamton Wastewater Study. The feasibility of returning to some of these alternatives that would not so directly impact the floodplain area could be explored. Such an alternative would clearly help to preserve the resources in question.

The second question cannot be answered in this report either, but it is an answerable question. Consistent with current Federal policy, the proposed research design for the second phase cultural resources survey will attempt to provide basic archeological information that will aid in designing the proposed project to have no adverse or minimal impact on significant cultural resources.

There is a twofold purpose to the cultural resources survey.

(1) A primary goal for the purpose of this study would be to find locations for the proposed sewer line that would have no direct adverse impact upon the cultural resources. Survey methods would be designed to perform this function as efficiently as possible within the boundaries imposed by the project. It should be noted that according to the proposed Corps of Engineers Policies and Procedures of September 1975, the results of cultural resource investigations shall be considered as of equal weight with other related studies at each stage of Corps planning, design and construction. This forthright policy is consistent with our own thinking.

(2) The second goal of the survey fieldwork would be to provide archeological data for the site files of the contracting institution of equivalent quality to that achieved through other similar contractual work that has been performed by the

institution. As with every piece of archeological work the intellectual return from this project would form its most compelling justification. Just as "pure" archeology is extremely untenable without a problem orientation; so contract archeology is intellectually unjustifiable as only a fulfillment of a contractual agreement. Therefore survey methods would also be designed to yield the most complete set of data obtainable with modern archeological techniques.

At present, intellectual goals upon which to fix archeological research in this area are difficult to define. This is a result of the sparcity of professional endeavor in this part of the country. A great deal of current archeological research in the Northeast is geared toward "filling in the gaps" in the archeological record. As this record grows and is organized specific problems will be discovered and applied to the performance of contract archeology. We mentioned a number of outstanding local problems earlier in the report.

The cultural resources reconnaissance followed a unilinear path through a part of the proposed corridor. This proposed study would involve an investigation of the entire broad corridor in the construction areas in an effort to identify specific locations for the pipes, plants and overflow areas where there are no archeological resources. To this end the proposed study would entail the following specific steps along with the indicated costs.

There should be a further, far more intensive sampling of the potentially impacted areas utilizing the test pit technique employed throughout the cultural resources reconnaissance. This technique is to be used both to minimize the excavational impact of the archeology itself upon the construction areas in the event that the construction may be moved and to provide qualitative information from the entire corridor.

Test pit excavation would be employed as an initial phase of the cultural resources survey. This type of survey technique allows relatively quick testing of the vegetationally obscured land surface in the Northeast without the precision and resultant costliness incurred employing excavation in preliminary stages of survey. The test pit program would be used to achieve three objectives.
(1) The delimitation of all known historic and prehistoric sites to be impacted by the project. This should involve the placement of an estimated 65 test pits; 50 to be dug near sites on the Owego interceptor line, 15 to be sunk near the old bank of the Chenango River near the proposed sewage treatment plant.

(2) An intensive sampling of the interceptor corridors. Test pits should be placed at ten meter intervals in two rows not more than ten meters apart along all segments of the proposed sewer corridor where it is feasible to dig test pits and which do not already lie within the area of a known site. These test pits should be dug to the depth of the proposed construction. Out of an estimated 300 required test pits approximately 200 should be dug on the Owego interceptor corridor while 100 should sample the areas of likely site occurrence on stretches of the Binghamton-Chenango interceptor corridor. Additional test pits should be placed adjacent to areas where cultural remains are identified to determine whether moving the sewer line would preserve the resources at the location. We estimate that 100 test pits may be necessary for this procedure.

(3) Twenty test pits should be placed in or adjacent to each of the overflow or sewage treatment site locations where evidence of cultural activity is indicated. Again efforts should be undertaken that would indicate whether moving the proposed site slightly would preserve the resource in question. We estimate 100 pits for this purpose.

(4) After all sites in the area to be impacted have been identified and delimited, a program of limited excavation should be performed. As a minimum, two 2x2 meter test squares should be opened at each of these locations. The analysis of materials obtained from these test squares would allow a specific assessment of the impact on cultural resources in the event that the sewer line, overflow site, or treatment plant cannot be moved. As many as 100 test squares may be required.

(5) Surveys and sample reconnaissance should be carried out in conjunction with sewer lines constructed to bring sewage to the new treatment plant and any additional construction undertaken in conjunction with the overflow areas.

(6) Survey and sample reconnaissance should be carried out in order to identify specific indirect impacts of the project.

The cost of (5) and (6) obviously cannot be estimated until the proposed project is more specifically defined. The costs of the first four items could be emcompassed within the following program.

Supervisory	100 man-days @ $120/day	$12,000
Test pits	70 man-days @ $40/day	2,800
2x2 squares	200 man-days @ $40/day	8,000
Laboratory	200 man-days @ $40/day	8,000
Report prep.	40 man-days @ $40/day	1,600
Supplies and expenses		500
Travel	2000 miles @ $.15/mile	300
Total (EXCLUSIVE OF INDIRECT COSTS)		$ 33,200

To the extent that the proposed project involves a deeply buried pipe, the use of power machinery to dig some or all test pits would be required increasing the project costs by about $2,000.

Given that such a project is carried out, and that modifications in the project design can be made, the amount of mitigation that would need to be carried out should be minimal. If the project design proceeds to a point where modifications in the exact locations of sewer lines, plants and overflow sites cannot be made before specific assessment work is done, the costs of mitigation will be substantial. Given the quantity of materials that have been recovered as a result of efforts to date, we estimate that if mitigation were required for all significant historic or prehistoric sites to be impacted by the project the cost would easily fall in the range of several hundreds of thousands of dollars. Again, if those responsible for the project and those responsible for preserving our cultural heritage work together effectively and carry out a thorough study before plans that can no longer be changed are made, the project can proceed and the resources can be preserved with minimum cost to all concerned.

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APPENDIX 1

NATIONAL REGISTER SITES IN BROOME AND TIOGA COUNTIES AS OF DECEMBER 31, 1974

<u>BROOME COUNTY</u>

Binghamton, Binghamton City Hall, Collier Street between Court and Academy Streets

Binghamton, Broome County Courthouse, Court Street

Binghamton, Christ Church, Washington and Henry Streets

Binghamton, Phelps Mansion, 191 Court Street

<u>TIOGA COUNTY</u>

Owego, Tioga County Courthouse, Village Park

APPENDIX 2

LITERATURE SEARCH : PREHISTORIC SITES

A variety of sources were consulted in constructing an inventory of prehistoric sites in Broome and Tioga Counties. These data will be summarized according to the source of the information.

(1) In his book, The Archeological History of New York (1922), Arthur C. Parker lists the following sites in the two counties:

Broome County

1a. village sites, west side of river at Chenango Forks

1b. cemetery on east side of river at Chenango Forks

2. 2 acre village site east of the mouth of Tracy Creek in Vestal

3. 15 acre site at the mouth of Nanticoke Creek

4. site similar to the above on the south side of the Susquehanna west of the mouth of Big Choconut Creek

5. site on river bank near Round Top Hill in Union

6. historic Indian village of Chugnuts

7. cemetery on bluff east of Union

8. shell heaps on north bank of Susquehanna in Union

9. shell heaps on south bank of above

10. site on 10 acre island in Big Choconut Creek southeast of Vestal

11a. Otsiningo on the Chenango River

11b. village at the mouth of Castle Creek

12. many camp sites along the Tioughnioga River between Chenango Forks and Whitney Point

13. Ouaquaga on the Susquehanna near Windsor

14. cemetery near modern Ouaquaga

15. cemetery near Windsor east of the river

16. village site east of the mouth of the Chenango River in Binghamton

17. camp site on south bank of river south of Binghamton

18. village site south of Stella on north bank of the Susquehanna

19. village site south of the above on south bank

20. camp sites along creek west of Deposit

21. village site 2 miles east of modern Ouaquaga

22. camp site 2 miles northeast of modern Ouaquaga

23. stone pile along old Indian trail from Ouaquaga to Binghamton

Tioga County

1. 2 acre village site in Candor
2. camp site on Thomas famwest of Owego Creek
3. camp site on Burt farm north of Catatonk
4. village site on Shaver farm on west bank of Owego Creek
5. burial site, 2 miles north of Newark Valley
6. camp sites on both sides of creek
7. village site on Holden farm on east branch of Owego Creek
8. village site on Wade farm
9. village site on Clinton farm in Newark Valley on east side of Creek
10. village site on Hammon farm near Wilson Creek
11. village site on Evans farm
12. village site south of Newark Valley
13. mound 1 mile south of Newark Valley on east bank of Owego Creek
14. camp site on Feming property, south bank of East Owego Creek
15. village site on Trune farm, Owego

16a. village site on Brown farm, Owego

16b. burial site on Brown farm, Owego

17. village site on Felming farm, east bank of Owego Creek
18. camp site on Pumpelly property, east side of Owego Creek

19a. village site west of Owego Creek in Owego

19b. burial site west of Owego Creek in Owego

20. village site in Owego, south of the river near the railroad bridge
21. village site on Goodrich farm
22. village site on Carb farm
23. village site on Nichols property
24. village site on Catlin property east of mouth of Appalachin Creek
25. village site on Tracey land
26. village site south of Hiawatha Island
27. village site, mouth of Nanticoke Creek, opposite Hiawatha Island
28. camp sites north of the Susquehanna, east of Appalachin Ferry
29. village site on Tillbury property
30. village site on Kidder's School Farm

31. burial site on land of Platt and Johnson west bank of Owego Creek
32. village site on Ingersoll farm near Tioga Ferry
33. village site on Lounsberry farm east of Tioga Ferry
34. camp site on Bauer property near Tioga Center
35. camp sites northeast of Tioga Center near mouth of Pipe Creek
36. camp site on Hardman Coal property on northwest bank of the Susquehanna
37. camp sites on Ferguson property north of Tioga Center
38. camp site southwest of Tioga Center along the river
39. village site on the LaMonte property
40. village site on the Smith property east of Canfield Corners
41. camp site west of Smithboro on north side of Susquehanna
42. village site on Corealls flat between Smithboro and Barton
43. village site east of Smithboro along river bank
44. village site in the town of Nichols
45. camp site in Nichols nearly opposite other camps across the river
46. village site west of Nichols near bend in the river
47. village site on south bank of the Susquehanna, southwest of Hooper Valley
48. village site on Ingersoll farm, Nichols
49. village site on Sherwood farm, Nichols
50. village site on Denham farm, Nichols
51. village site on Harris farm, Nichols
52. village site on Johnson farm, Nichols
53. burial site 1/2 mile west of Barton
54. camp site in Tioga on north side of the Susquehanna
55. camp site on lot 7, town of Nichols
56. village site on Manghatamanga Flats
57. village site on east side of the Susquehanna north of the state boundary in the town of Nichols
58. camp site 1/2 mile northwest of Waverly
59a. village site on the north side of the Susquehanna above Waverly
59b. burial site on the north side of the Susquehanna above Waverly
60. camp site on the east side of Cayuta Creek, 3 miles north of Waverly
61. camp site on the west side of Cayuta Creek at the mouth of Miller Run
62. camp site on the east side of Cayuta Creek, 1/2 mile north of Lockwood

(2) Files of the Triple Cities Chapter of the New York State Archaeological Association

The files of the Triple Cities Chapter record the location of 38 sites in Tioga County (numbered SuBi-301-338(and 19 sites in Broome County (numbered SuBi-339-357).

(3) Files of the Department of Anthropology, State University of New York, Binghamton, The Files of the Department of Anthropology, State University of New York, Binghamton, list one site in Tioga County (SuBi 220) and 16 sites in Broome County (SuBi-02-05, 21, 187, 188, 254, 185, 186, 252, 265, 285, 454, 200, 253).

(4) In his book, Traces of Early Man in the Northeast (1957), Ritchie lists the following finds of PaleoIndian points:

Tioga County

#45 Nichols

#46 Nichols

Broome County

#47 Kirkwood

#48 Union

#49 Windsor

(5) In his book, The Pre-Iroquoian Occupations of New York State (1944), Ritchie lists the following sites in Broome County: Castle Creek, Damascus Site, Clark Site and Palmer Site.

(6) In his book, The Archaeology of New York State (1969), Ritchie lists the Round Top Site in Broome County.

(7) In his manuscript, Archaeological Salvage Work on New York State Highways, 1963-1969 (1970), William Engelbrecht lists fourteen sites in Broome and Tioga Counties, the Kruemberg Site, June Site, Strong Site, Smithboro Site, and Sites 1-10.

(8) In their manuscript, The Engelbert Site, Dolores Elliot and William Lipe list the Engelbert Site outside Nichols in Tioga County.

(9) At present, there are no prehistoric sites in either Broome or Tioga County listed on the National Register of Historic Places.

(10) The files of the State Archeologist, New York State Museum and Science Service, are not open to the public for projects with a scope as large as this one.

The location of these sites is shown on the accompanying map. (Some site locations were not described in sufficient detail to allow inclusion on the map.) Again, anyone using the map should recall the very incomplete reflection of archeological resources in the area that it provides.

MAPS OF TEST PIT LOCATIONS WITHHELD IN ACCORDANCE WITH ENGINEERING CIRCULAR 1105-2-37 (8 AUG 1975) TO PREVENT POSSIBLE VANDALISM AT SPECIFIC SITES.

APPENDIX 4
TEST PIT PROFILES

(Note: These test pits are the width of a shovel. Therefore, the term "profile" is used in a very general sense.)

SUNY BINGHAMTON ARCHAEOLOGICAL SURVEY - SHOVEL TEST PIT RECORD

Binghamton Wastewater Reconnaissance

PROJECT, PIN

T or KM

PROP TRACT Owego Interceptor Line

CREW Stong
DATE 10/11/75
PAGE 1 OF 5

PZ-PLOWZONE SA-SAND
HU-HUMUS BG-BL-GR CLAY
SI-SILT OT-OTHER
GR-GRAVEL 10-OCCUP 1..N

STP NO.	C	S	BD	ED	S	BD	ED	S	BD	ED	S	FINAL BD	ED	CM?	REFRENCES
468 901		HU	0	32	BG	32	35							brick chips	151/15
1		HU	0	13	Sa,Si	13	39	BG	39	42				brick	153/1
2		OT	0	15	Sa,Si	15	60	rusty BG	60	75				brick cinders	153/1
3		OT	0	18	OT	18	62							brick cinders	153/1
469 901		HU	0	15	Sa,Si cinders	15	30	black cinders	30	55	brown Sa,Si	55	85	historic	151/15
469 902		brown Sa,Si	0	80										historic	153/1
469 903		HU	0	32	Si	32	85							historic	151/16
4		dk.brn Sa,Si	0	85										No	153/1
5		HU	0	25	Sa,Si	25	75							No	153/1
460 901		HU	0	5	Sa,Si	5	85							chipped stone	151/16
6		black HU	0	10	Sa,Si	10	63							No	153/1
7		HU	0	22	Si	22	70							No	151/16
470 901		HU & cinders	0	27	Sa,Si	27	65							historic	153/3
8		HU	0	20	Sa,Si	20	63							historic	153/3
9		HU	0	28	Si	28	65							No	151/16
10		HU	0	42	Sa,Si	42	66							No	153/3
461 901		HU	0	34	Sa,Si	34	68							1 pcs. debitage	153/3
11		HU	0	30	Sa,Si	30	65							No	151/17
12		HU	0	33	Si	33	60							No	151/17

SUNY BINGHAMTON ARCHAEOLOGICAL SURVEY - SHOVEL TEST PIT RECORD

PROJECT, PIN ____________ CREW ____________
T or KM ____________ DATE ____________
PROP TRACT ____________ PAGE ____ OF ____

PZ-PLOWZONE
HU-HUMUS
SI-SILT
GR-GRAVEL

SA-SAND
BG-BL-GR CLAY
OT-OTHER
10-OCCUP 1..N

STP NO.	C	S	BD	ED	S	BD	ED	S	BD	ED	S	FINAL BD	ED	CM?	REFRENCES
13		HU	0	37	Sa,Si	37	62							No	153/4
14		HU	0	30	Si	30	62							No	151/17
15		HU	0	23	Si	23	62							No	153/4
16		HU	0	26	Si	26	60							No	153/4
462 901		HU	0	25	Si	25	60							2 pcs debitage	151/17
462 902		HU	0	28	Si	28	58							1 pc. debitage	153/4
462 903		HU	0	25	Si	25	60							1 pc. debitage	151/17
17		HU	0	28	Si	28	50							No	153/5
463 901		HU	0	22	Si	22	55							1 pc. debitage	151/17
18		SaHV	0	37	Si	37	53							No	153/5
19		cinder	0	27	Si	27	30							No	151/18
20		OT	0	24	BG	24	32							No	153/5

SUNY BINGHAMTON ARCHAEOLOGICAL SURVEY - SHOVEL TEST PIT RECORD

Binghamton Wastewater Reconnaissance

PROJECT, PIN ______ CREW Strong

T or KM ______ DATE 10/11/75

PROP TRACT Binghamton Interceptor line PAGE 2 OF 5

PZ-PLOWZONE
HU-HUMUS
SI-SILT
GR-GRAVEL

SA-SAND
BG-BL-GR CLAY
OT-OTHER
10-OCCUP 1..N

STP NO.	C	S	BD	ED	S	BD	ED	S	BD	ED	S	FINAL BD	ED	CM?	REFRENCES
464 901		SiGr	0	23	Si	23	35	Cl	35	50				2 pcs debitage	152/3
1		HU	0	40	Si	40	60							No	152/4
464 902		BG	0	58										1 pc/ ch. stone	152/4
464 903		HU GR	0	60	Si Gr	60	65							2 flakes netsinker	152/5
464 904		HU GR	0	14	Si Gr	14	62							1 pc. debitage	152/6
2		Si Gr	0	55										No	152/6
3		Si	0	10	Si	10	60							No	152/7
4		HU Cl	0	38	Si Gr	38	50							No	152/9
5		Si Gr	0	35	Si Gr	35	45							No	152/11
6		Si Gr	0	37	Cl	37	50							No	152/9
7		HU	0	10	grey clay	10	36	yellow clay	36	45				No	152/11
8		HU	0	8	Si	8	32	yellow clay	32	40				No	152/12
9		Sa Gr	0	10										No	152/12
10		Si	0	45	Si	45	55							No	152/15
11		Si	0	52										No	152/15
12		Si	0	25	Si Cl	25	48							No	152/16
13		Si	0	50										No	152/16
14		Si	0	55										No	152/17
15		Si	0	50										No	152/17

SUNY BINGHAMTON ARCHAEOLOGICAL SURVEY - SHOVEL TEST PIT RECORD

PROJECT, PIN ____________ CREW ____________
T or KM ____________ DATE ____________
PROP TRACT ____________ PAGE ____ OF ____

PZ-PLOWZONE SA-SAND
HU-HUMUS BG-BL-GR CLAY
SI-SILT OT-OTHER
GR-GRAVEL 10-OCCUP 1..N

STP NO.	C	S	BD	ED	S	BD	ED	S	BD	ED	S	FINAL BD	ED	CM?	REFRENCES
16		Si	0	50										No	152/17
17		Gr	0	5	Si	5	45							No	152/17
18		Si Gr	0	5	Si	5	55							No	152/18
19		Si Gr	0	30										No	152/18
20		Si	0	38	Cl	38	45							No	152/18

SUNY BINGHAMTON ARCHAEOLOGICAL SURVEY - SHOVEL TEST PIT RECORD

Binghamton Wastewater Reconnaissance

PROJECT, PIN ______ CREW Stong
T or KM ______ DATE 10/12/75
PROP TRACT Unitarian Church Overflow Area PAGE 3 OF 5

PZ-PLOWZONE SA-SAND
HU-HUMUS BG-BL-GR CLAY
SI-SILT OT-OTHER
GR-GRAVEL 10-OCCUP 1..N

STP NO.	C	S	BD	ED	S	BD	ED	S	BD	ED	S	FINAL BD	ED	CM?	REFRENCES
1		Cl Gr	0	25	Cl Gr	25	40	Cl Sa Gr	40	50				historic	154/1
2		Si	0	20	Si Cl	20	45	Gr	45	50	Gr Cl	50	55	No	154/1
3		Si	0	20	Si Gr	20	47							No	154/1
4		Si Gr	0	22	Cl Si	22	59							No	154/1
465 901		HU	0	23	Si Cl	23	51	Cl Si	51	60				Historic	
5		Si Gr	0	14	Si Gr	14	50							No	151/23
6		Cl	0	20	Cl Si	20	28	Si	28	47	Cl	47	52	No	154/2
7		Cl Si	0	28	yellow clay	28	27							No	151/23
8		Sa Si	0	37	yellow clay	37	55							Coal	151/24
9		HU	0	16	Cl Si	16	28	Sa Cl	28	45				Coal	154/3
10		Hu Si	0	5	Si Gr	5	23	Si Gr	23	43	Sa Gr	43	50	No	152/20
11		Hu	0	8	Si Gr	8	38							No	152/20
465 902		Si	0	10	Si Gr	10	30	Si Sa Gr	30	40				chipped stone	152/20
12		Si Gr	0	50										No	152/21
13		HU	0	15	Si	15	45							No	151/23
14		HU	0	12	Si	12	30	GR	30	38				Coal	152/21
15		HU	0	28	Si	28	39	Si	39	50				No	152/22
16		HU	0	26	Si	26	45	Cl Gr	45	50				No	152/22
17		HU	0	15	Si	15	30	Si Cl	35	35	yellow clay	35	47	No	152/22

SUNY BINGHAMTON ARCHAEOLOGICAL SURVEY - SHOVEL TEST PIT RECORD

PROJECT, PIN ______ CREW ______
T or KM ______ DATE ______
PROP TRACT ______ PAGE ____ OF ____

PZ-PLOWZONE SA-SAND
HU-HUMUS BG-BL-GR CLAY
SI-SILT OT-OTHER
GR-GRAVEL 10-OCCUP 1..N

STP NO.	C	S	BD	ED	S	BD	ED	S	BD	ED	S	FINAL BD	ED	CM?	REFRENCES
18		HU	0	20	Si	20	48	yellow clay	48	50				No	152/22
19		HU	0	14	Si Cl	14	32	yellow clay	32	47				No	152/23
20		HU	0	30	Sa Si	30	50							No	151/24

SUNY BINGHAMTON ARCHAEOLOGICAL SURVEY - SHOVEL TEST PIT RECORD

PROJECT, PIN Binghamton Wastewater Reconnaissance
T or KM
PROP TRACT Temple Concord Overflow Area

CREW Stong
DATE 10/12/75
PAGE 4 OF 5

PZ-PLOWZONE
HU-HUMUS
SI-SILT
GR-GRAVEL

SA-SAND
BG-BL-GR CLAY
OT-OTHER
10-OCCUP 1..N

STP NO.	C	S	BD	ED	S	BD	ED	S	BD	ED	S	FINAL BD	ED	CM?	REFRENCES
357 901		OT	0	30										1 pc debitage	151/25
357 902		HU	0	5	Sa,Si Gr	5	27							1 flake	151/25
357 903		OT	0	23	Si	23	43							2 pc. deb. 2 blocks	151/25

SUNY BINGHAMTON ARCHAEOLOGICAL SURVEY - SHOVEL TEST PIT RECORD

PROJECT, PIN ____________________ CREW ____________________
T or KM ____________________ DATE ____________________
PROP TRACT ____________________ PAGE _____ OF _____

PZ-PLOWZONE SA-SAND
HU-HUMUS BG-BL-GR CLAY
SI-SILT OT-OTHER
GR-GRAVEL 10-OCCUP 1..N

STP NO.	C	S	BD	ED	S	BD	ED	S	BD	ED	S	FINAL BD	ED	CM?	REFRENCES

SUNY BINGHAMTON ARCHAEOLOGICAL SURVEY - SHOVEL TEST PIT RECORD

PROJECT, PIN Binghamton Wastewater Reconnaissance
T or KM
PROP TRACT Chenango Valley Treatment Site
CREW Strong
DATE 10/12/75
PAGE 5 OF 5

PZ-PLOWZONE
HU-HUMUS
SI-SILT
GR-GRAVEL

SA-SAND
BG-BL-GR CLAY
OT-OTHER
10-OCCUP 1..N

STP NO.	C	S	BD	ED	S	BD	ED	S	BD	ED	S	FINAL BD	ED	CM?	REFRENCES
466 901		BG GR	0	30										1 block	151/26
1		BG GR	0	30										No	151/26
466 902		Cl Gr	0	20	si	20	40							chipped stone	151/26
2		BG Sa	0	45										No	151/26
466 903		Si Gr	0	30										1 flake	151/27
3		Si Gr	0	30										No	151/27
4		SH Gr	0	30										No	151/27
5		Si Gr	0	30										No	151/27
6		HU	0	70										No	152/24
7		HU	0	50										No	152/24
8		HU	0	60										No	152/24
9		HU Si	0	54										No	152/24
10		HU Si	0	60										No	152/24
11		HU Gr	0	20										No	152/26
12		HU	0	55										No	152/26
13		HU Gr	0	55										No	152/26
14		HU	0	60										No	152/26
467 901		HU Gr	0	10	Si Gr	10	26							1 block 4 pcs debitage	152/26
467 902		Hu Gr	0	20	Si Gr	20	40							4 flakes 4 pcs debitage	152/27

SUNY BINGHAMTON ARCHAEOLOGICAL SURVEY - SHOVEL TEST PIT RECORD

PROJECT, PIN ______________ CREW ______________
T or KM ______________ DATE ______________
PROP TRACT ______________ PAGE _____ OF _____

PZ-PLOWZONE SA-SAND
HU-HUMUS BG-BL-GR CLAY
SI-SILT OT-OTHER
GR-GRAVEL 10-OCCUP 1..N

STP NO.	C	S	BD	ED	S	BD	ED	S	BD	ED	S	FINAL BD	ED	CM?	REFRENCES
467 903		HU GR	0	10	Si Gr	10	41							7 pcs debitage	152/27
467 904		HU GR	0	30	Si Gr	30	40							1 flake 2 pcs debitage	151/28
467 905		Hu GR	0	34										3 flakes 2 pcs.debitage	151/28

APPENDIX 5

PHOTOGRAPHS OF ARTIFACTS AND SITE LOCATIONS

Fig. 1

Site 471 on Owego Interceptor Route (N135°E)

Fig.2

Area near Site 462, Pits 901, 902 and 903 (N50°W)

Fig. 3

Old Chenango River Bed, Site 466, Pits 901, 902 and 903 (N)

Fig. 4

Old Chenango River Bed, Site 466, Pits 901, 902 and 903 (N15°E)

Fig. 5

Old Chenango River Bank, Site 467, Pits 901-905 (N15°W)

Fig. 6

County Gardens near U.S. Dept. of Agriculture Building (N15°E)

Fig. 7

Bevier Street Bridge, Site 464, Pits 901-904 (N70°E)

Fig. 8

Bevier Street Bridge, Site 464, Pits 901-904 (N110°W)

Fig. 9

I-81 River Park - Comfort Station (N30°E)

Fig. 10

Overflow Site #11 (N150°W)

Fig. 11

Overflow Site #2, Site 465, Pits 901, 902 (N65°W)

Fig. 12

Overflow Site #2, Site 465, Pits 901, 902 (N20°W)

Fig.13

Overflow Site #4, Site 357, Pits, 901, 902 and 903 (N140°W)

Fig.14

Overflow Site #4, Site 357, Pits 901, 902 and 903 (N110°W)

Fig. 15

Overflow Site #15 (E)

Fig. 16

Overflow Site #15 (N120°E)

Fig.17

Overflow Site #8 (E)

Fig.18

Overflow Site #8 (N120°W)

Fig. 19

Artifacts; Owego Interceptor, Sites 460, 461, 462, 463, Bevier Street Site 464

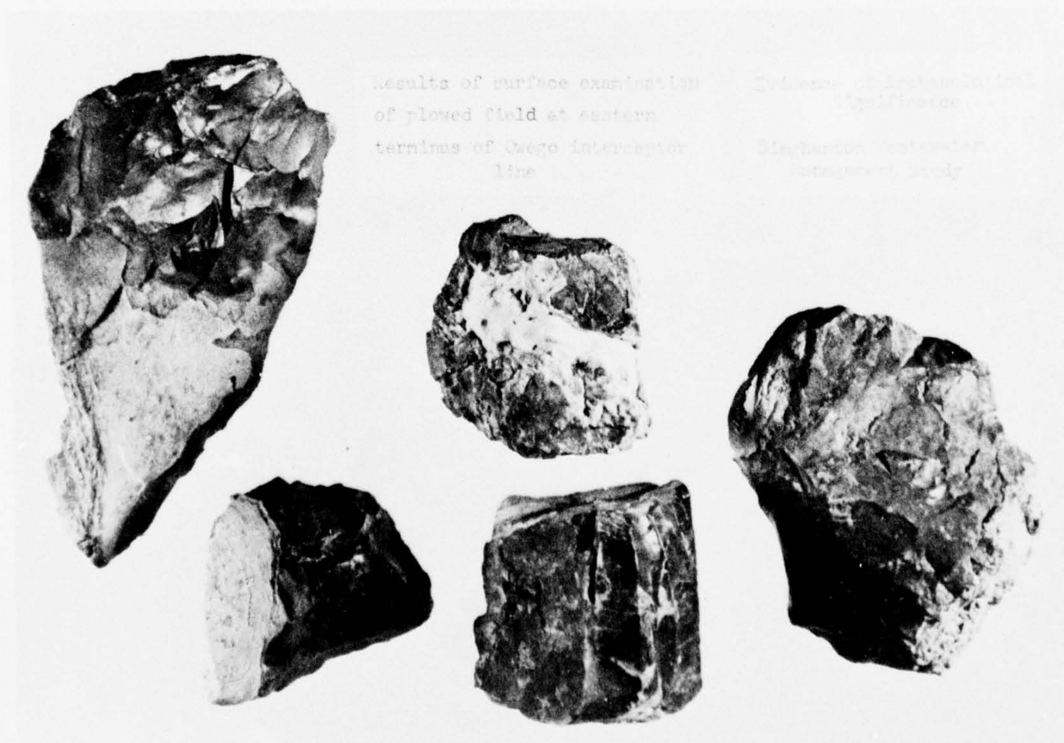

Fig. 20

Artifacts; Site 471

Fig. 21

Artifacts; Overflow Sites #2, #4, Old Chenango Riverbed, Site 466

Fig. 22

Artifacts; Old Chenango River Bank, Site 467

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